AMERICAN ENGINEER AND RAILROAD JOURNAL.

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AMERICAN ENGINEER TESTS.

LOCOMOTIVE DRAFT APPLIANCES.

XI.

Report by Professor W. F. M. Goss.

SECTION V.

The Tests.

(*Continued from Page* 298.)

29. A Résumé.—This report has already extended itself over a considerable course. In the four sections which have preceded, there have been presented a general discussion of the stack problem and a description of the special equipment employed in carrying out the present investigation. Descriptions have also been given of the preliminary experiment in using oil as fuel, the difficulties encountered in controlling perfectly the conditions at the grate, and of an elaborate experimental study of the draft conditions within the front-end, designed to disclose the correct point of attachment for the draft gauge. To these descriptions from the laboratory there have been added the results of a carefully conducted research by Professor Forsyth, concerning the limiting dimensions applying to stack design, as presented in a large number of examples drawn from modern practice. These preliminaries having been disposed of, it remains now to describe briefly the process of running the tests, and to present the results, and the conclusions which may be drawn therefrom.

30. The Tests.—The original outline contemplated observations concerning stack performance under a steam pressure of 180 lbs., a cut-off of approximately one-third stroke, and at speeds of 20, 30 and 40 miles an hour. The considerations leading to the choice of these conditions have already been set forth in paragraph 4. As the test proceeded, it seemed best in the case of certain of the series to include speeds of 50 and 60 miles, and, also, to add a new series for which the cut-off was varied while the speed remained constant at 40 miles an hour. A summarized statement of all conditions covered is as follows:

Variable Speed Series.

Constants.	Variables.
Boiler pressure, 180. Throttle wide open. Cut-off, per cent. of stroke, 23.8.	Speeds, 20, 30, 40, 50 and 60 m. p. h.

Variable Cut-Off Series.

Constants.	Variables.
Boiler pressure 180. Throttle wide open. Speed, 40 miles per hr. 194 revolutions per min.	Cut-off, per cent. of stroke, 19, 23.8, 26.9 and 35.

With the exception of certain conditions which could be omitted without interfering with the value of a series, tests were run under each condition specified above, for each of 40 different stacks, and these again were repeated for from two to seven different heights of exhaust pipes. To these conditions must also be added others applying to an inside or sliding stack, the results of which will be separately considered. The tests as actually made involved 1,032 distinct tests, for each of which the locomotive was brought under specific conditions of running, and for each of which a considerable series of

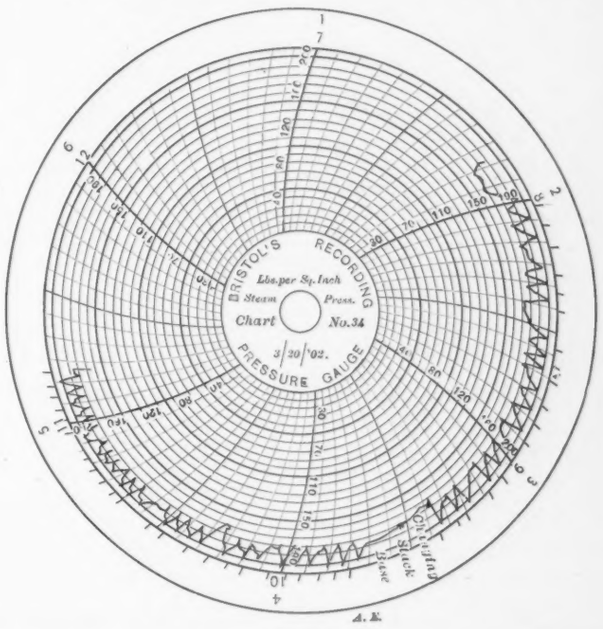


FIG. 22.

observations were made of permanent record. Besides these recorded tests there have been many other trial or rejected tests.

31. The Running of the Tests.—In anticipation of a series of tests, the engine was warmed by preliminary running. It was then started for a test, and after the throttle and reverse-lever had been brought to their desired positions, the speed of the engine was made to vary by changing its load. When the speed and the steam pressure were both that which were required, the signal was given and observations were taken. The engine was then stopped and such changes in stack or nozzle were made as were necessary for the next set of observations, after which the process above described was repeated. In this manner a day's work consisted in a succession of short runs with intervals between to allow the change of equipment.

32. Observations.—As a check on results, it was planned to have each condition observed simultaneously by two different observers, each using independent instruments. In the work-

ing out of this plan, it was found convenient to make the observations from one set of instruments the permanent record, and to hold the other set as checks upon the first.

The speed was determined from the dial of a Boyer speed recorder, the indications of which were checked repeatedly during each day's run by a comparison with the record of a registering counter. The readings of the registering counter were taken during a one-minute interval immediately following the signal.

The boiler pressure which, when all observations were taken, was intended to be 180, was observed by means of a gauge in the cab, checked by the indications of a Bristol recording gauge. While the record of the gauges is to be regarded only as a check upon more accurate observations, and thus intended merely to detect any gross error on the part of the observer, a typical chart (Fig. 22) will not be without interest. Each rise and fall of the steam pressure curve represents a test. When the locomotive was started the pressure was usually high. By varying the load a constant speed could be maintained while the pressure was allowed slowly to fall. When the finger of the gauge in the cab had reached 180, the signal for observations was given. The diagram indicates the rapidity with which the work was advanced. The marks outside the margin of the chart were made to indicate the hour when the several signals were given.

The back-pressure was observed by means of a U-tube filled with mercury, calibrated to read in pounds per square inch, and also by a low pressure Bristol recording gauge, both gauges being connected with the exhaust port of the cylinder saddle. Here again the Bristol gauge record is to be regarded merely as a check. A typical chart covering the same interval as that representing boiler-pressure chart is presented as Fig. 23. In general, the high points on the curve represent conditions of tests, but in this diagram, as in others, reference lines appear on the margin. A comparison of the gauge records will show that the record points in Fig. 23 represent hours for which the steam pressure (Fig. 22) was 180 lbs.

For a considerable portion of the work it was sought to further check the back-pressure record by means of an indicator fitted with a 10-lb. spring, having a stop to prevent too great a movement of the piston, and attached to the cylinder in the usual manner. It was not expected that values thus obtained would be the same as those obtained from gauges attached to the exhaust port, but rather that some relation would be found to exist between them, which would be helpful as an additional check. Experience soon disclosed, however, that the value of this record was insufficient to warrant the continued use of the indicator. The exhaust line, as recorded by use of a light spring, is a generous curve, the form of which varied considerably under different conditions of speed. For this reason no useful result could be obtained by always measuring the pressure at the same point in the stroke, and when this plan of procedure was abandoned, and when due regard had been given to the effect of inertia in the indicator, it was difficult to determine from the card what was the least back-pressure. The significance of this statement will appear from Fig. 24, which presents three back-pressure cards taken under identical conditions except as to speed. Finally as to back-pressure, it should be noted that this factor is the most troublesome of all those which were sought to be obtained. The difficulty grows out of the narrow range in the pressures to be measured, and also from the possibility of water of condensation collecting in the gauge pipes. While many precautions were taken to secure accuracy in this particular, it must be admitted that from an experimental point of view, these values are the least satisfactory of all those which were taken

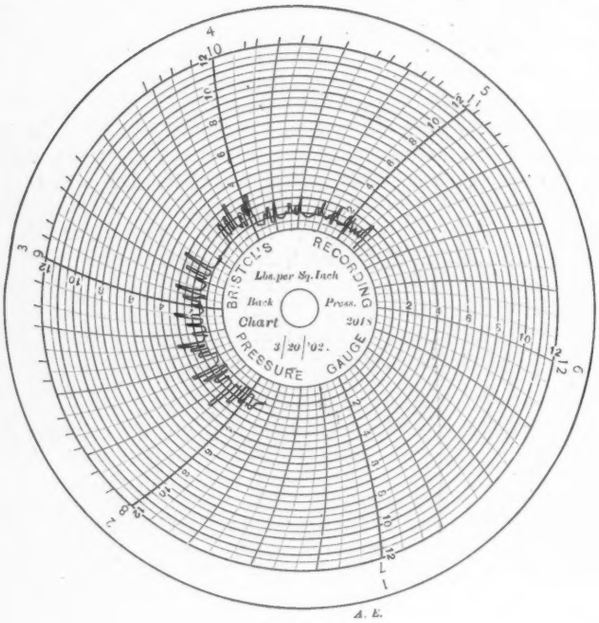


FIG. 23.

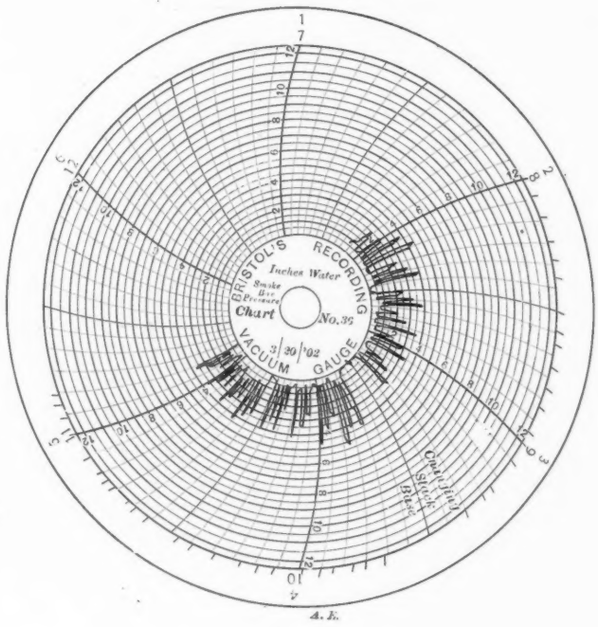
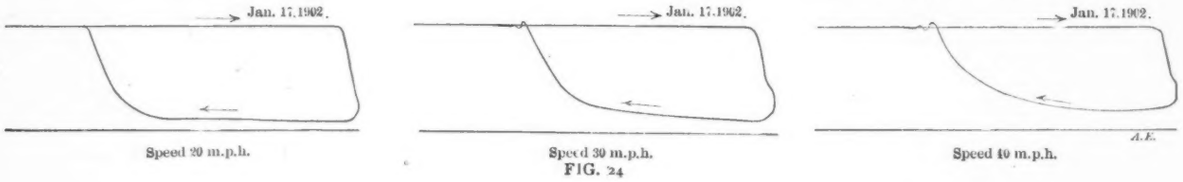


FIG. 25.



Speed 20 m.p.h. Speed 30 m.p.h. Speed 40 m.p.h.

FIG. 24

The draft was determined by means of a U-tube gauge filled with water, checked by the indications of a Bristol recording gauge. The chart from the recording gauge covering the same intervals of time as those from other gauges presented, is given as Fig. 25.

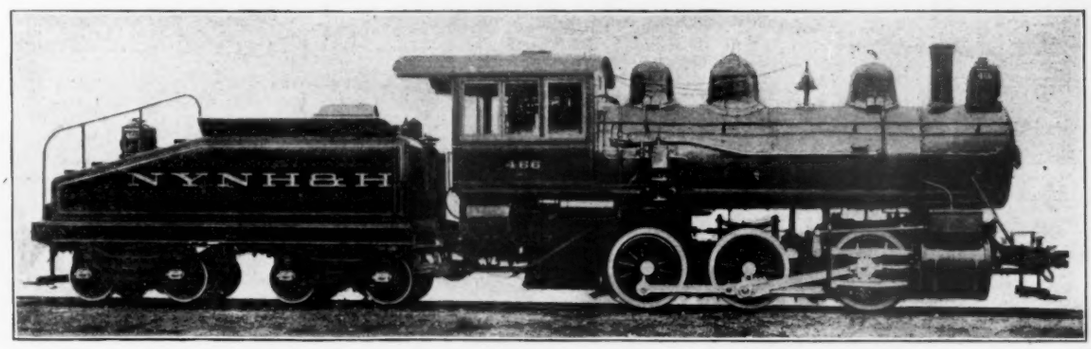
It should be added for the benefit of those who may desire to study the records of the several recording gauges that all tests represented were at the same speed and cut-off. The same exhaust nozzle (No. 1) was used; the only changes were in respect to height and diameter of stack. Keeping this statement in mind, a glance at Fig. 25 will be sufficient to show that very considerable differences in draft may result from changes in stack proportion.

Normal indicator diagrams were obtained from one side of the engine for a sufficient number of tests to perfectly define the power developed by the engine under each condition of running. Copies of these will be found presented with the data.

TWO-CYLINDER COMPOUND SWITCHING LOCOMOTIVE.

New York, New Haven & Hartford Railroad.

The accompanying engraving is an illustration of a six-coupled, two-cylinder-compound locomotive, designed especially for heavy yard work, that has recently been built by the American Locomotive Company at their Rhode Island Works, for the New York, New Haven & Hartford Railroad. The Rhode Island's system of two-cylinder compounding has been applied, and the steam pressure to be carried is 215 lbs. per sq. in. Considerable interest is excited in this engine, on account of the unusually high working pressure that it is to carry, as well as also on account of the fact that the compound principle has not been very extensively used in yard service. The boiler is straight-top with radial stays and has a rather large heating surface for yard work. The design throughout gives evidence of generous proportions intended for heavy yard service, the maximum draw-bar pull capable of being exerted being 30,700 lbs. The principal dimensions of this interesting locomotive are given below:



Two-Cylinder Compound Switching Locomotive.

New York, New Haven & Hartford Railroad.

JOHN HENNEY, *Superintendent of Motive Power.* AMERICAN LOCOMOTIVE COMPANY, Rhode Island Works, *Builders.*

Six-Coupled Two-Cylinder-Compound Switching Locomotive.
New York, New Haven & Hartford Railroad.

General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Anthracite coal or coke
Weight in working order	135,800 lbs.
Weight on drivers	135,800 lbs.
Weight engine and tender in working order	219,000 lbs.
Wheel base, driving	11 ft. 6 ins.
Wheel base, total	11 ft. 6 ins.
Wheel base, total, engine and tender	42 ft. 3½ ins.

Cylinders.

Diameter of cylinders	H. P., 20½ ins.; L. P., 31 ins.
Stroke of piston	26 ins.
Diameter of piston rod	3½ ins.
Kind of piston packing	Cast-iron spring rings
Kind of piston-rod packing	Metallic

Wheels.

Diameter of driving wheels outside of tire	51 ins.
Material of driving wheel, centers	Main, cast steel; front and back, cast iron
Tires, held by	Shrinkage; thickness, 3½ ins.
Driving-box material	Cast steel
Diameter and length of driving journals	9 ins. diameter x 12 ins.
Diameter and length of main crank-pin journals	6 ins. diameter x 5½ ins.
Diameter and length of side-rod crank-pin journals	Front and back, 5 ins. diameter x 3½ ins.; int., 6¾ x 4½

Boiler.

Style	Straight (extended front end)
Outside diameter of first ring	62⅜ ins.
Working pressure	215 lbs.
Material of barrel and of firebox	Carbon steel
Firebox, length	102⅛ ins.
Firebox, width	39¼ ins.
Firebox, depth	Front, 61¾ ins.; back, 64¾ ins.
Firebox plates, thickness	Sides, back and crown, ⅜ in.; tube sheet, ½ in.
Firebox, water space	4 ins.; front and sides, 3½ ins.
Firebox, crown staying	Radial, 1⅛ in. diameter
Firebox, stay bolts	1 in. diameter
Tubes, material and gauge	Charcoal iron, No. 11, B. W. G.
Tubes, number	236
Tubes, diameter	2 ins., O. D.
Tubes, length over tube sheets	11 ft. 6 ins.
Fire brick, supported on	Lugs
Heating surface, tubes	1,416 sq. ft.
Heating surface, firebox	144 sq. ft.
Heating surface, total	1,560 sq. ft.
Grate surface	28 sq. ft.
Grate, style	Shaking grate without water tubes

Tender.

Style	Tank with sloping top
Weight, empty	37,880 lbs.
Wheel base	17 ft.
Tender frame	10-in. channels (steel)
Tender trucks	Fox pressed steel
Water capacity	4,000 U. S. gals.
Coal capacity	Anthracite coal, 6 tons

WAGES ON FRENCH RAILROADS.

France is not a place for high wages for railroad employees. Consul-General J. K. Gowdy, writing from Paris, says that an ordinary porter receives $21.55 a month, a head porter $25.33, a pointsman from $25.77 to $28.06, and a plate layer $18.50. The driver of a locomotive earns on an average $36 per month, and his "rewards" for saving coal, etc., usually amount to $14. Stokers receive about $25 per month, with $5.50 as extras. A foreman in the workshops earns as much as $48.50 per month, an ordinary workman $19.30, and an apprentice $14. Of 71,273 men working on the principal railroads 56 per cent. receive from $16.59 to $26.05 per month, and 84 per cent. get from $13.70 to $31.84 per month. The men work, on an average, 28½ days per month, and from 7 to 12 hours a day. Nearly 15 per cent. of the men are lodged.

In England long distance runs without stops are common. On the London & Northwestern two remarkable runs have been made. A special train run in connection with the trial trip of a new steamship recently made a run of 299 miles without a stop, and the new Viceroy of Ireland was carried from London to Holyhead, a distance of 262 miles, without an intermediate stop.

NEW LOCOMOTIVE AND CAR SHOPS.

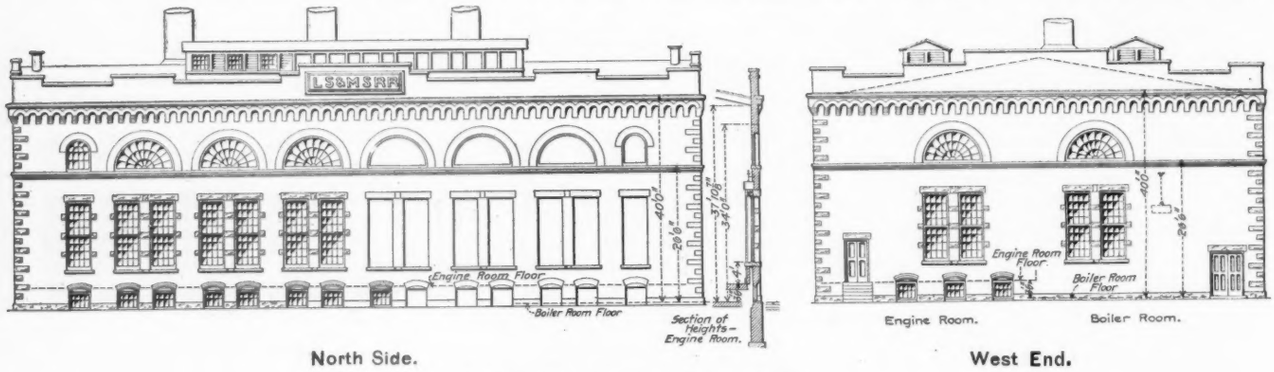
Collinwood, Ohio.

Lake Shore & Michigan Southern Railway.

II.

Power House.

One of the most important features of modern railroad shops is the power plant and its equipment; the practice in modern shops is tending almost universally toward the concentration of all power generation into one building and electrical distribution from that one point to the points of power consumption. The advantages of this method of power distribution have been made use of in the new Collinwood shops of the Lake Shore & Michigan Southern Railroad to an extent and degree of completeness far surpassing that usually found in shops for railroad or other work. A power generating plant capable of furnishing all the power to be needed in the entire shops, both for motors and for electric lighting, has been installed at a point on the shop grounds very close



North Side. West End.

Exterior Elevations of Power House.

to the theoretical center of distribution with respect to the consumption of power, from which point electric current is delivered to the various buildings through conductors located in underground tunnels. The state of development exemplified in this plant, not only with respect to the details of the steam and electrical machinery, but also to the character of the building itself, is not excelled by that of any other plant of its kind.

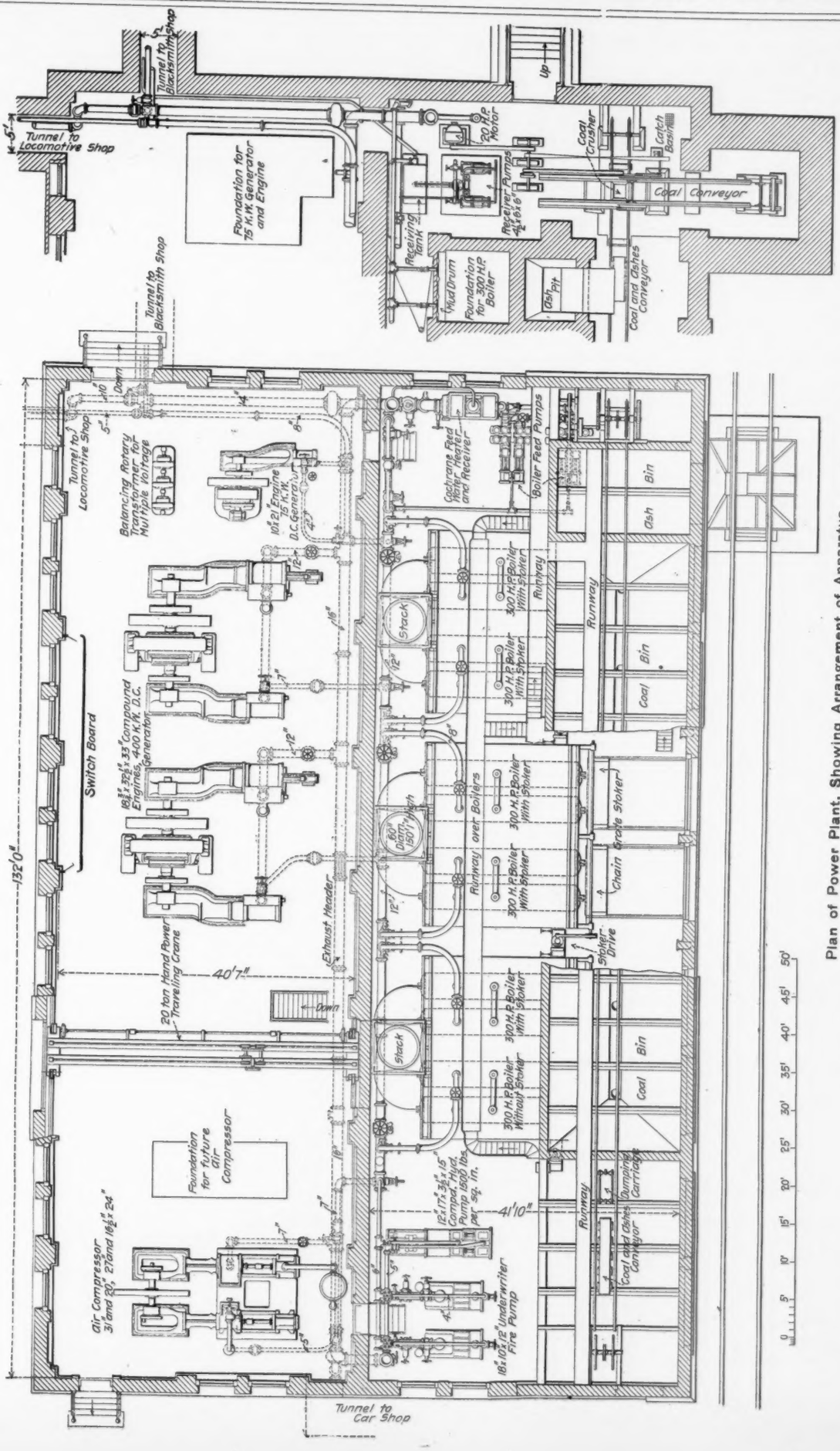
Building.

The building for the power house has many notable features, it being of very solid and durable construction and presenting by its exterior appearance the general impression of strength and substantial construction so noticeable in the machine-shop buildings. This building is also built up of steel and brick, with liberal provision of windows for daylight lighting, as may be seen by reference to the accompanying side and end elevations of the building. The design of this structure gives evidence also of an effort to embody a pleasing exterior appearance, this building and the office building being, in fact, the only structures in connection with the shops upon which an effort was made for ornamentation.

The foundations of the building are of concrete, 39 and 42 ins. thick, the mixture being one part of Atlas Portland cement to eight parts of gravel and fine broken stone. The basement walls vary from 31 to 38 ins. in thickness, the partition wall between the boiler and engine room basements being the thickest. The outside surfaces of the basement walls are covered with a heavy coat of asphalt put on hot for waterproofing, while the inside surfaces are smoothed off with a coating of strong cement mortar. The floors of the two basements, which are 8 ft. 3 ins. below the yard level, are of an asphalt binder mixture, 5 ins. thick, composed of ¾-in. broken stone and gravel mixed with hot asphalt in the proportion of 1 gal. of the liquid to 1 cu. ft. of the heated stone. This was well rammed in while hot and then dressed over to a correct surface with a ½-in. layer of asphalt. The surfaces of the floors are graded to the corners, where catch-basins are located for draining, being connected with 8-in. cast-iron sewer pipes; these sewer pipes have Y-connections, from which branches are led out through the basement floor for connection with the headers from the roof.

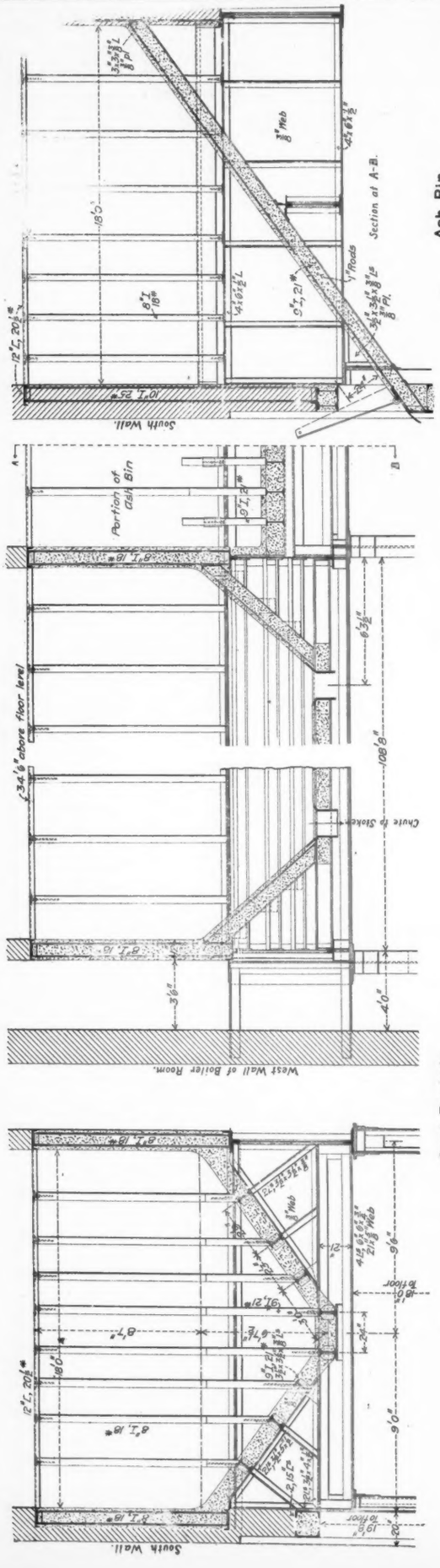
The walls of the engine and boiler rooms are all 21 ins. in thickness, with the exception of the partition wall and the north wall of the engine room, which are 26 inches thick. The inner sides of the engine-room walls are finished with a 12-in. baseboard of dark Tennessee marble, above which, and up to a distance of 10¾ ft., was plastered a coat of cement mortar composed of two parts of cement to three parts of sand. The window sills are also of marble. All the posts of the steel framework of the building between the windows are filled with concrete and faced over with brick, the thickness of the wall being increased at those points to 34 ins. in the engine room and to 54 ins. in the boiler room, on account of the enlarged posts there supporting the great weight of the elevated coal bunkers. The steel posts are set on steel wedges, ½ in. thick, and when adjusted were cast in with a joint of clean Portland cement. All of the steel work that is covered with cement or mortar was first painted with a coating of hot asphalt of such a consistency as to dry thick and glossy; where it is left exposed it was first painted with red lead mixed in pure linseed oil and afterwards with a color.

The roof is undoubtedly the most remarkable feature of the power-house building. The objectionable features of wooden or other roofs of a combustible nature, as well as the injurious effects of dripping condensation from all-metal roofs in winter have here been entirely obviated by the construction of a hollow-tile roof. Four-inch T-shaped bars were laid inverted upon the steel roof frame as purlins and then filled in with 4-in. terra-cotta tiles set in cement mortar, thus forming a solid tile roof. Gutters were then formed with mortar by filling in with it and troweling it smoothly up against the parapet walls, and so grading as to shed water into the leaders to the sewer. The roof was smoothed over completely with cement mortar to fill up all cracks, and the entire lower surface of the roof was plastered over flush with the lower sides of the T-iron purlins. Upon the top of the tile filling five courses of the best roofing felt were laid, each course being bedded in hot asphalt and each strip of felt overlapping its neighbor by one-fifth of its width. All the courses are laid in an unbroken layer in the gutter up against the parapet wall, each being cemented up under a joint in the parapet capping. A course of screened gravel laid in a thick layer of hot asphalt above the felt completes the roof. The rain leaders are connected to the roof through copper flashings 30 ins. square, set into the tile and overlapped by the roofing felt; these flashings lead down through copper-wire screens to 4-in. wrought-iron rain



Plan of Power Plant, Showing Arrangement of Apparatus.

Central Power Plant at Collinwood Shops — Lake Shore & Michigan Southern Railway.



Sectional Elevation Views of Coal Pockets and Ash Bin, Showing Details of Construction.

headers, which are located inside the building to insure immunity from freezing and flooding in cold weather. This mode of roof construction leaves little to be desired in the matter of absolute protection to the most delicate of machinery.

Another remarkable feature of the building, indicating the substantial character of its construction, is the design of coal storage pockets and ash bin, which are of steel and concrete, built permanently into the upper portion of the boiler room, as shown in the elevation views in the supplement. The coal pockets are supported upon 21-in. built-up plate girders, 18 ft. 6 in. long, which span across from steel posts set in the south wall of the boiler room to similar steel posts located between the boiler settings. Upon these girders rest special triangular-shaped plates arranged to support the sloping portions of the base of the bin, which are built up of 9-in., 18-lb. I-beams laid longitudinally and filled in between with concrete. The ends of the trough-shaped bottom of the bunkers are also built in slanting from the edge of the stoker feed-holes up to the end walls with a similar concrete-filled construction of 9-in. I-beams fitted in with specially shaped fittings to the longitudinal I-beams, as shown, preventing accumulations of coal at the ends. The side and end walls of the pockets are built up of 8-in., 18-lb. I-beams with the solid concrete filling between them. The ash bin is similar in construction to that of the pockets, with the exception of being smaller and differently shaped; the slope of its base is all in one direction at an angle of 45 degrees toward the south wall of the building, the lower end of the base ending in a chute running through the wall, with a 24-in. clearance. The chute ends outside in a lip hinged to the wall and counter-weighted to swing up and down; when raised up, the lip acts as a door to close the chute, and when down as a trough delivering to car. The construction of the bins is very clearly illustrated in the accompanying detail drawing.

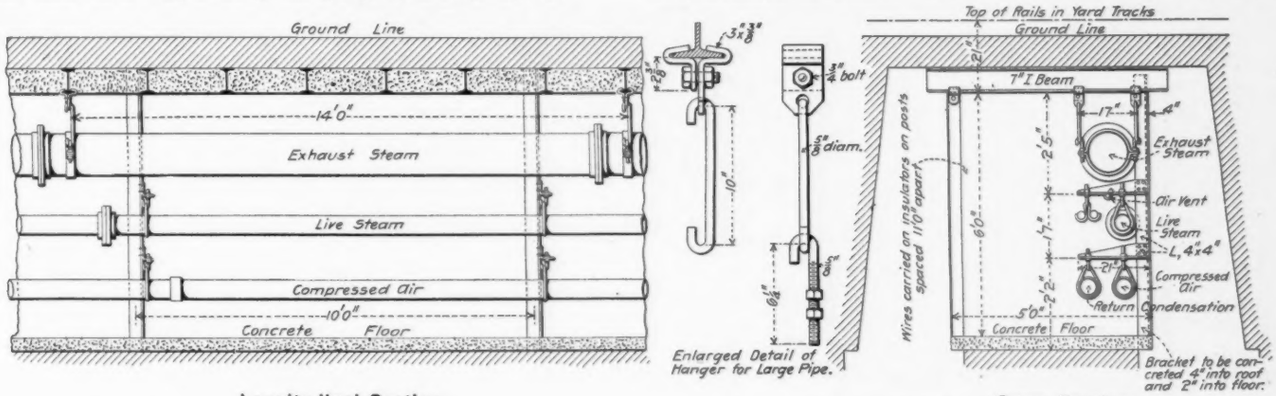
Equipment.

The equipment of the power plant, both mechanical and electrical, is fully in keeping with the character of the building in which it is housed, not only with respect to the thoroughly high-grade character of the apparatus, but also to the extreme completeness of detail manifested in the installation. The general design gives evidence of the expenditure of great care here, as well as throughout the shops, in the selection of apparatus and the planning of details for the best results and reliability in operation.

A very noticeable feature of the power plant is the complete automatic system of handling the fuel, no manual handling of coal being necessary from car to the stokers, thus reducing to a minimum the labor necessary in the boiler room. Coal is delivered to the power house by dumping direct from the car into a pit located outside the southeast corner of the boiler room, underneath the side-track alongside the building, through which it enters the conveyor system. This pit contains a receiving hopper of ¼-in. steel plate, which receives the coal dumped down and directs it into a short auxiliary apron-feed conveyor, running northward, carrying it to the crusher and main conveyor within the boiler-room basement. The apron-feed conveyor discharges the coal into a hopper feeding into the coal crusher, which breaks it up, if necessary, to the size required for the stokers; after leaving the crusher the coal drops into another hopper below, from which it is fed into the main bucket conveyor system for delivery to the coal pockets above.

The apron-feed conveyor feeds into the crusher's hopper in regular quantities, avoiding clogging or overloading the crusher. The crusher is of a very heavy pattern, 24 x 24 ins. in size, with a solid tooth roll. Both the crusher and the apron-feed conveyor are run by a 22 horse-power electric motor made by the Milwaukee Electric Company. The main conveyor is of the pivoted-bucket type, consisting of malleable iron

buckets, 18 x 24 ins. in size, pivoted to two strands of 24-in.-pitch chain, which is fitted with self-oiling flanged rollers for running on the conveyor track. The buckets have overlapping ends, thus forming a continuous trough, which does not open up anywhere in transit except when on vertical section of conveyor track or when passing the dumping carriage, and thus does not require a feeder hopper. The dumper carriage is a tripping mechanism arranged below the conveyor track over the coal pockets, which will dump the buckets as they pass it. It may be placed in any location over the pockets for dumping and filling up at that section, its position being adjustable from the boiler room floor. This main conveyor also will take care of the ashes from the furnaces. Ash pits of bowl-shape are located in the boiler foundations below the stokers from which the ashes may be scraped out into the conveyor passing in front, and then by adjusting the dumper carriage properly they are dumped into the ash bin above, ready to be loaded into cars outside. The main bucket conveyor is operated by a 7½ horse-power electric motor, also furnished by the Milwaukee Electric Company, through a special set of equalizing gears transmitting an even motion. The conveyor travels on a track of 16-lb. T-rails. The entire conveyor system, and also the coal crusher, were supplied by the Link-Belt Engineering Company, Philadelphia, Pa.



Longitudinal Section. **Cross Section.**

Sections of the Piping and Wiring Tunnel, Showing Arrangement of Pipes and Details of Flexible Pipe Hanger.

for the lining of the surfaces exposed to the fire, exclusive of the flue.

To five of the six boilers, the Mansfield travelling chain-grate stoker has been applied, which was also furnished by the Aultman & Taylor Machinery Company. The Mansfield stoker consists of a wide band, or chain, made up of short link-like sections of grate bars pivoted after the fashion of a sprocket chain, which band travels around two drums in the fire-box, being so driven that the upper side moves backward from the boiler front toward the arch. Coal is fed evenly on to the moving chain as it recedes by a feeding hopper outside the front, which hopper is supplied directly by the coal chutes leading from the coal pockets above. The coal burns as it travels with the grate, the speed of travel being so adjusted that when rear drum is passed the coal is entirely consumed, leaving ashes only to be dumped off at the end—this entirely obviates cleaning fires. The stokers are driven by small vertical steam engines geared to drive the drums very slowly through ratchet mechanisms. It may be mentioned that steam engines were considered preferable to electric motors for this service inasmuch as they may be run when getting up steam or at any time steam is on, and are not dependent upon the dynamos running. The entire chain-grate mechanisms are mounted in frames with wheels running on tracks embedded in the boiler room floor so that the stokers may be easily withdrawn from the boiler settings for inspection or repairs. The arrangement of the grate links in the grate chain, or band, which is 8 ft. 4¾ ins. in width, is clearly shown in the illustration of the boiler fronts on page 337, as well as also a coal chute from the pockets above to a stoker hopper. One boiler is fitted with fire doors and stationary grates, instead of a stoker, in order to burn shavings and refuse from the wood mill and cabinet shop which will be delivered to the boiler room by a shavings exhaust system. Each battery of boilers has a separate steel stack, 60 ins. in diameter and 150 ft. 1 in. high, natural chimney draft by individual stacks having been considered preferable to forced or induced draft systems.

Boilers and Stokers.

Steam for the plant is furnished by six 300-h. p. sectional water-tube boilers of the Cahall horizontal type, installed by the Aultman & Taylor Machinery Co., Mansfield, Ohio, in batteries of two each as indicated in the plan view of the power house on page 333. These boilers are of the inclined-tube type, consisting of 16 sections of tubes, each containing nine 4-inch tubes, 18 ft. long, expanded into vertical headers at both front and rear, and two steam and water drums, each 42 ins. in diameter and 20 ft. 2 ins. long, located horizontally in the tops of the settings and connected to the tube headers at each end by special fittings. The tube headers at the rear end of the inclined tubes are connected at their lower ends, the lowest point, to a mud drum.

The total heating surface of each boiler is 6,040 sq. ft., and its grate area, 67.66 sq. ft., making thus 89.2 sq. ft. of heating surface per sq. ft. of grate area, a very high ratio for stationary boilers. Each boiler is equipped with two 4-in. safety valves, set to 150 lbs. per sq. in., and has an 8-in. steam-outlet connection running from the nozzle to the main steam header with large radius bends and no elbows. The Reliance safety water column, made by the Reliance Gauge Column Co., Cleveland, Ohio, has been applied to each boiler, embracing safety-self-closing gage-glass valves and an automatic low-water whistle alarm. The space occupied by each boiler, measured over the setting, is 20 ft. 2 ins. in length, 24 ft. 2 ins. in width and 16 ft. 8 ins. in height to top of nozzle. Each boiler required 26,500 common red bricks for the masonry in the setting, not including the foundation, and 8,670 fire-bricks

Boiler Auxiliaries.

The boilers are fed by two outside-end-packed duplex boiler-feed pumps which were furnished by the Snyder-Hughes Co., Cleveland, O. These pumps, which have cylinders 12 ins. and 7 ins. by 12 ins. stroke, are of the pot valve type and have capacity each to feed 1,800 h. p. of boilers. They are connected to take water from either the feed-water heater or the water supply, and are controlled by Foster pump governors, which render their action automatic, the feed being controlled entirely at the feed valve on the boiler. The feed water is passed through a Cochrane exhaust-steam feed water heater and purifier of the "open" type, which delivers it free from oil and at a temperature of from 2 to 5 degrees of that of the steam entering. Large depositing surface is provided in this

heater for the water to have the greatest possible opportunity to deposit all impurities that the temperature of the exhaust will precipitate. The depositing trays are 25 by 18 ins., 20 in number, and the space for filtering material is 48 by 48 ins. by 49 ins. deep. The floor space required is 78 by 53 ins. The effect of the contact of the exhaust steam with the water in the heater is its partial condensation and consequent partial reduction of back pressure in the exhaust system and also a considerable quantity of condensed steam reclaimed. Cold water is automatically fed into the heater as fast only as it is required to supplement that condensed from the steam. This heater was supplied by the Harrison Safety Boiler Works, Philadelphia.

At the west end of the boiler room are installed two 18 x 10 x 12-inch stroke Barr Underwriter type duplex fire pumps, which were furnished by Dravo, Doyle & Co., Cleveland, O. These pumps have a capacity of delivering 1,000 gals. per minute and are adapted to fully meet the underwriters' requirements for constant priming, quick starting, etc. Adjoining the fire pumps is a compound duplex hydraulic pressure pump furnished by the Henry R. Worthington Company, New York. The cylinders of this pump are 12 and 17 by 3½ ins., with a 15-in. stroke, and the piping connections are as follows: Live steam, 2½ ins.; exhaust steam, 3½ ins.; hydraulic suction, 2½ ins., and delivery, 2 ins. This pump will, with 150 lbs. steam pressure, deliver up to 80 gals. per minute against a head of 1,500 lbs. pressure.

Engines.

The engine equipment of the plant will consist of one 150 horse-power simple engine, two 650 horse-power cross-compound engines, all direct-connected to engine-type multipolar dynamos, and two compound air compressors; at present, however, the 150 horse-power engine, one 650 horse-power engine and one compressor only are installed, the others to be placed later. The engines are the well-known automatic cut-off shaft governor type, manufactured by the Buckeye Engine Company, Salem, O. The simple engine has a 10 x 21-inch cylinder, and the compound has cylinders 18¾ and 32½ x 33 ins. The compound engine runs, with the rated steam pressure of 150 lbs. per square inch, at a speed of 135 revolutions per minute, and is guaranteed to regulate within 2 per cent. above or below that speed. Its rated power is 650 horse-power, but it has a range of economical working from 520 to 750 horse power, its ultimate capacity being 860 horse power. The size of the steam-admission pipe is 8 ins. and the exhaust 12 ins. This engine is guaranteed not to consume more than 19½ lbs. of dry steam per horse-power hour at its rated full load. The 150 horse-power engine is intended for the night lighting load, periods of light load, or any time when load is too low to be economical for the compound engine.

The air compressor is of the direct-connected fly-wheel type, with compound steam and compound air cylinders and separate intercooler, furnished by the Franklin Plant of the Chicago Pneumatic Tool Co. It has steam cylinders 20 and 31 x 24 ins. and air cylinders 16½ and 27 x 24 ins., the capacity being 1,500 cu. ft. of free air delivered per minute at a speed of 100 revolutions per minute. It delivers at a pressure of 100 lbs. per square inch with 80 lbs. steam pressure. The air inlet and discharge valves are of the poppet type, while the steam valve motion is the Meyer adjustable cut-off system. The fly-wheel is 120 ins. in diameter, with an 8-in. face. The intercooler is of the multitubular water-cooled type, and the heated water from it is used for boiler feeding if there is not a surplus of water in the heater, in which case it is discharged through a safety valve to the sewer.

Piping.

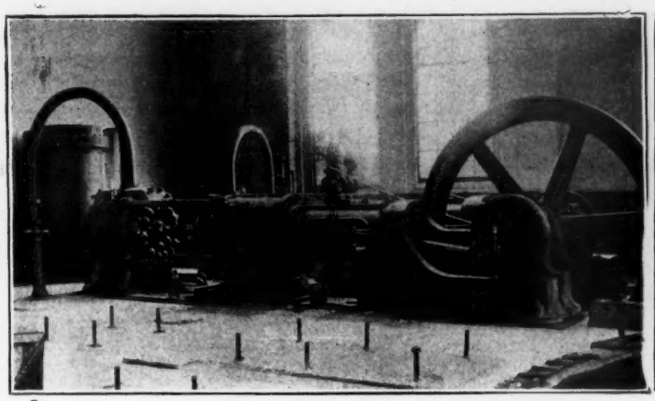
That the piping for a plant of this size and importance is of equal, if not greater, importance than the apparatus itself, has been manifested by the careful attention that has been paid to this detail. Often far too little attention is paid to the piping in the best of stationary plants. The general arrangement of the piping systems, steam, exhaust, etc., is apparent by reference to the plan of the plant on page 333, or to the elevation views in the supplement, but an idea of the grade of construction may best be had from the following quotations from the piping specifications: All high-pressure steam pipe lines above 2½ ins. diameter to have flange fittings and all 6-in. pipe and over to have flanges of rolled steel; all 8-in. pipe and smaller to be full-weight wrought iron, according to the standards of A. M. Byers & Co., of Pittsburg, and larger pipes, including 12-in., to be full-weight standards of the National Tube Works Company; all valves for 2-in. pipe and smaller to be solid brass gate valves with inside screws, except where used for throttling valves, when globe valves will be used; all valves for 2½-in. pipe and over to be iron body, outside screw and yoke, and rising spindle; 8-in. valves and over to have by-pass valves; boiler-feed pipes to be "extra strong" wrought-iron, with screwed joints and rolled steel flanges; blow-off pipes from boiler to be "extra strong" and equipped with asbestos-packed valves; water supply system to be best quality cast-iron pipe, to withstand 150 lbs. pressure; hydraulic-pressure line, which runs to accumulator in boiler shop and to blacksmith shop, where it is flanged for possible future use, to be "double extra strong" wrought-iron pipe, and to have flange fittings; all pipe lines 4 ins. in diameter and above to have flange unions every 50 ft. The contractor for the piping installation is the Best Manufacturing Company, Pittsburg, Pa.

The water-supply pipe is connected to the elevated tanks, situated to the west of the power house, for reserve supply, and also a connection is made to this tank from the city water supply for supply in emergency. Check valves are located in the delivery from the tank to the hydrant mains in the yards, so that when fire-pump pressure is on water will not back up into tank.

In the steam-piping system there is a 12-in. main steam header, to which all the boilers feed through Guland non-return angle valves and 8-in. double-bend W. I pipes. This header runs the length of the building behind the boilers and just above the level of the engine-room floor, and is divided up into sections by gate valves to enable different parts to be cut out. Steam connections are taken off the header as follows: A 6-in. pipe to each fire pump and to the hydraulic-pressure pump; a 7-in. pipe to the air compressor; a 7-in. pipe to the 650 horse-power engine, and a 4-in. to the 150 horse-power engine; an 8-in. pipe to the locomotive and blacksmith shops for various uses. Also a 3-in. connection to the heating system, to the boiler-feed pumps, and to two 4½ x 6 x 6-in. Snyder-Hughes receiving pumps in the basement used in connection with the heating system returns. The exhaust steam from all the engines and pumps is received by a 16-in. exhaust header running the length of the building in the engine-room basement, which header is connected to the heating system and to the feed-water heater, with also a Kieley back-pressure valve at each end, admitting exhaust to atmosphere through two exhaust heads on the roof in case of back pressure in the system. Condensation from the high-pressure steam pipes, separators, etc., are returned to the boilers by a No. 3 Holly return-system, cylinder cock drains being discharged into the exhaust pipe and all low-pressure drains into the receiving tank in basement.

Dynamos.

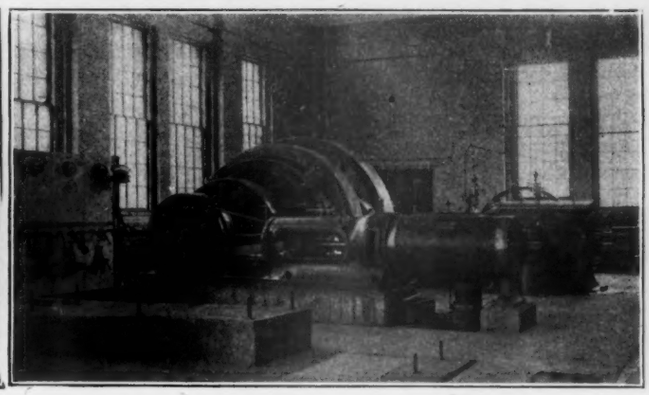
The dynamos are compound-wound multipolar slow-speed engine-type generators, mounted directly by pressure fit onto the engine shafts, and were built by the Crocker-Wheeler Company, Ampere, N. J. The dynamo connected to the 150 horse-power engine is of 75 kilowatts, and the one to the 650 horse-power engine of 400-kilowatt capacity, both being over-compounded about 4 per cent. so as to rise in voltage from the no-load normal of 240 volts to 250 volts at full load. The 400-kilowatt machine, which runs at a speed of 130 revolutions per minute, has 12 poles, and has a commutator 60 ins. in diameter with a 16-in. face. The current output at full load is 1,666 amperes, the entire range of load from no-load to full load being



Air Compressor, C-S-C Type.

With Compound Steam and Compound Air Cylinders, and Inter-cooler.

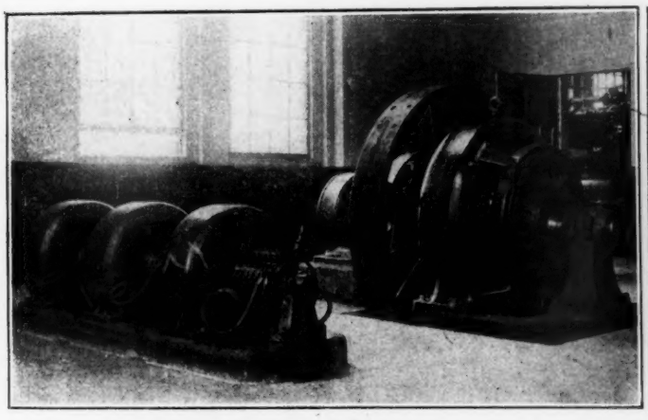
(Foundation in foreground for compressor to be installed.)



400-K.W. Multipolar Dynamo

Direct-Connected to Cross-Compound Engine.

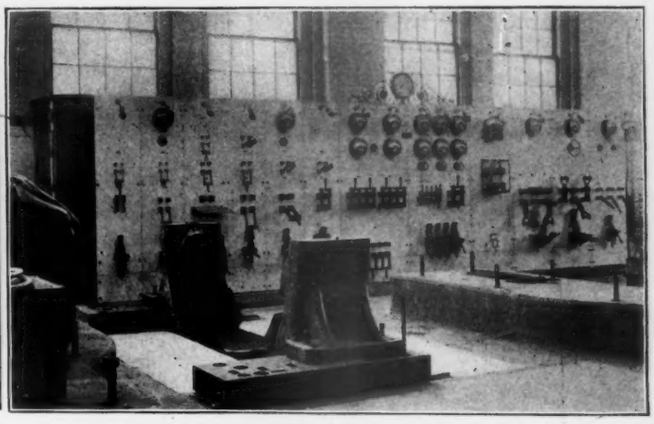
(Foundation in foreground for additional unit to be installed.)



75-K.W. Multipolar Dynamo

Direct-Connected to Simple Automatic Cut-Off Engine.

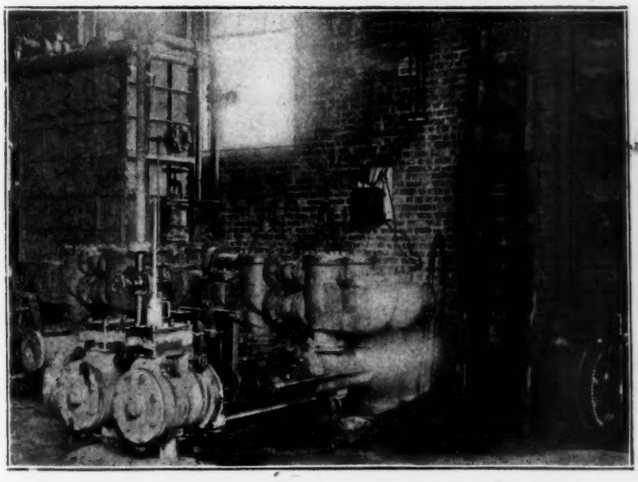
Balancing Rotary Transformer for Multiple Voltage in Foreground.



Twelve Panel Switchboard.

With Special Multiple-Voltage Panels.

(Foundation and base-frame in foreground for additional generator unit to be installed.)



Feed-Water Heater and Purifier, and Boiler Feed Pumps,

Bucket Coal and Ashes Conveyor to the Right.

View in Boiler Room,

Showing Boiler Fronts, Chain-Grate Stokers, and Coal Chute to Stoker Hopper from Pockets Above.

Central Power Plant.

Collinwood Shops—Lake Shore & Michigan Southern Railway.

delivered free from sparking without adjusting the brushes, and even momentary overloads as high as 75 per cent. (2,916 amperes) being possible without injurious sparking. The guaranteed efficiencies of the 400-kilowatt dynamo are: 93 per cent. at 25 per cent. overload, 93.75 per cent. at full load, 93.5 per cent. at three-quarters load, 92.5 per cent. at half load and 89 per cent. at one-quarter load.

The general electrical distribution system is a two-wire system operating at 240 volts, but in addition to this there is also a four-wire multiple voltage system for use in obtaining tapped off of any one of the three machines, or off of either two of them combined, giving with a main voltage six available voltages, ranging as follows: 40 volts, 80 volts, 120 volts, 160 volts, 200 volts and 240 volts; and with the 30-kilowatt capacity in each machine, 60 kilowatts is available at any one of the intermediate voltages. This capacity is, of course, very low, compared with the total capacity of motors installed in the shops using the multiple voltage, but it is totally improbable that all, or even that a very large number, of tools will be run at the same time off of the same pair of wires of the

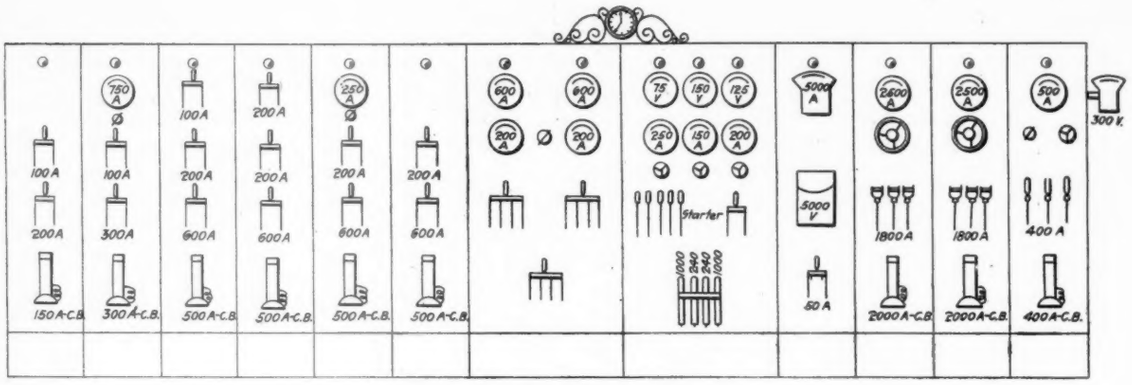


Diagram of Switchboard, Front Side.

Showing Arrangement and Capacities of Instruments.

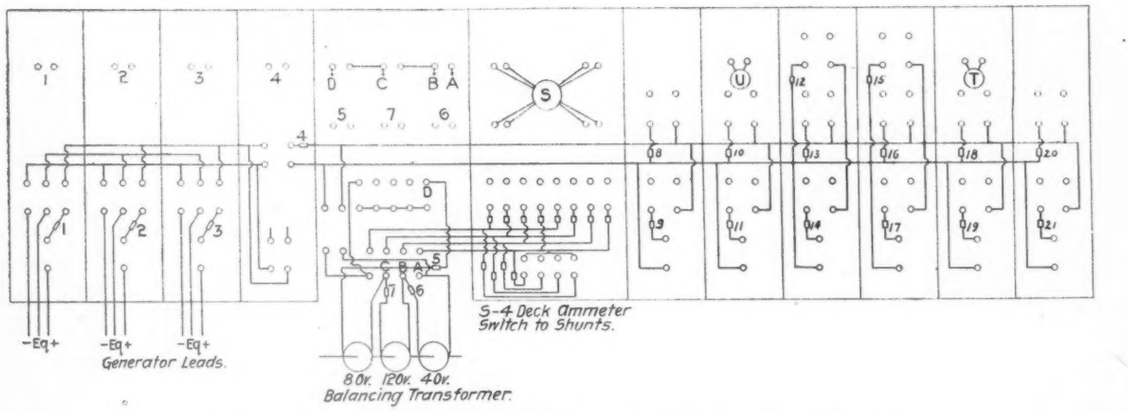


Diagram of Rear of Switchboard, Showing Arrangement of Wiring Connections.

Central Power Plant.

Collinwood Shops. — Lake Shore & Michigan Southern Railway.

variable speeds at the motors of the motor-driven machine tools in the machine shop. The Crocker-Wheeler Company's multiple-voltage system of speed control was adopted, and, for producing the intermediate voltages without rheostatic losses, a triplicate balancing rotary transformer is used, consisting of three size 25-D Crocker-Wheeler motors mounted on a common base, and with armatures on one shaft, as shown in the illustration of the 75-kilowatt dynamo on page 337. The three armatures are wound for 80, 120 and 40 volts respectively, and each machine has a capacity of about 30 kilowatts. The connections of the armatures of this transformer are shown in the diagram of wiring of the switchboard on this page, the three armatures being practically connected in series across the main circuit from the generators, and, running as a motor-dynamo, transform and deliver currents at the above-named voltages at their terminals; thus current may be multiple-voltage system; when there are loads across different branches of this four-wire system they will, of course, tend to balance each other and thus relieve the rotary transformer in the power plant, the function of the rotary transformer being merely to balance up whenever the load is unequally divided between the main leads of the system.

Switchboard.

The switchboard is a beautiful 12-panel board of 2-in. white Italian marble, as shown in the illustration on page 337. The panels are all of a uniform height of 6 ft. 6 ins. and have small 12-in. baseboard panels underneath them next to the floor. The arrangement of the panels, from right to left, is as follows: Three generator panels, each 24 ins. wide; one total output panel, 24 ins. wide; one transformer panel and one multiple-voltage panel, each 3 ft. 6 ins. wide, and six

feeder panels, each 21 ins. wide. The first generator panel, at the right, contains a 400-ampere single-pole circuit breaker, three 400-ampere single-pole main knife switches, a 500-ampere ammeter, a field rheostat, and also a six-point voltmeter switch for connecting the main swinging-bracket voltmeter to any desired circuit at will. The other two generator panels each contain a 2,000-ampere single-pole circuit breaker, three 1,800-ampere single-pole main knife switches, a field rheostat and a 2,500-ampere ammeter. The total output panel contains a 5,000-ampere ammeter, to indicate the total output of the plant, a 5,000-ampere Thompson recording wattmeter, to record the total output, and at the bottom a 50-ampere double-pole knife switch controlling the lighting circuits of the power house. The transformer panel contains three voltmeters and three double-reading ammeters, as indicated on the switchboard diagram, page 338, for indicating the voltages and loads on the three branches of the multiple-voltage system, three field rheostats for the balancer machines, and a five-pole starting switch for starting up the balancer. At the base of the board is a four-pole, four-coil, four-arm overload and no-voltage circuit-breaker, of which all four of the latches are mechanically connected so that an overload in any one of the four legs trips all the breakers. The two outside arms of this circuit breaker are each of 1,000 amperes capacity, normal rating, and the two inside arms of 240 amperes capacity; this difference in capacity between the outside and inside arms of the circuit is partly because of the balancing of the motors among themselves on the multiple-voltage system so that the intermediate wires may be less in size than the outside wires, and partly because a portion of the power is supplied directly to motors which run at constant speed on the full voltage and so never make use of the intermediate wires.

The remaining seven panels of the board to the left are essentially feeder panels. The first is the multiple-voltage panel, having three four-pole main multiple-voltage feeder switches and four ammeters, two of 600 amperes and two of 200 amperes capacity. Two of the four-pole switches have outside blades of 600 amperes and inside blades of 200 amperes capacity, while the other has two arms of 400 and two of 100 amperes capacity respectively. A special four-deck three-point ammeter switch is provided on this board, by means of which all four of the ammeters may simultaneously be thrown onto any one of the three four-wire feeder circuits. The six remaining feeder panels contain 14 switches, of sizes indicated on the switchboard diagram, which control the entire distribution for light and power on the general two-wire 240-volt system, and two of the panels have ammeters with the necessary multi-point ammeter switches for connecting them to any of the feeder circuits. The six lower switches on these six panels control power circuits delivering current to the various shops, cranes, transfer tables, etc., and it is in these circuits that the circuit breakers at the bases of the panels are connected; four of these circuit breakers are of 500 amperes, and the other two of 300 and 150 amperes capacity.

The circuit breakers are all of the laminated edgewise type I-T-E circuit breakers manufactured by the Cutter Company, Philadelphia, and all are placed at the lower edge of the board. The ammeters and voltmeters are all the well-known Weston station-type instruments, the main bracket voltmeter and the total-output ammeter being of the illuminated-dial type, while all the others are of the round-pattern switchboard type. The switches for the board are calculated to carry not over 1,000 amperes and not to exceed 50 amperes per square inch of contact area in the clips at full load. All nuts on the switches have a clamping surface of 1 sq. in. per 150 amperes capacity. These proportions permit overloads up to 25 per cent. without injury. The bus bars behind the switchboard are of pure copper ¼ or ⅜ in. thick, with ¼-in. spaces opening between sections, and are calculated on the basis of 800 amperes carrying capacity per square inch of cross-section and with hot over 150 amperes to pass per square inch of contact area. The bus bars extend the entire length of board, as shown in the wiring diagram of rear of board. All the switches are protected by D. & W. inclosed fuses mounted on separate panels at the back of the main panel, which are easily accessible. The duplicate numbers on the generator panels indicate the positions of the ammeter shunts and of the terminals of the ammeters to which they are connected; on the feeder panels the numbers indicate the shunts which may be connected by means of the ammeter switches, the power feeders to the 750-ampere ammeter and the lighting feeders to the 250-ampere ammeter. The switchboard frame is surmounted by a large clock set in ornamental framework, and each panel is separately lighted by incandescent lamp brackets. The entire switchboard, with its equipment, was furnished and installed by the Western Electric Company, Chicago.

Crane.

The engine-room crane is a 20-ton hand-power traveling crane, with 40 ft. 8 ins. span, furnished by the Browning Engineering Company, Cleveland. The main hoist of the crane has a speed of from ¾ ft. per minute at full load to 2 ft. per minute at no load; the trolley will travel from 12 ft. per minute at full load to 18 ft. per minute at no load, while the bridge travels from 8 ft. per minute at full load to 10 ft. per minute at no load. The crane is built up of I-beams, with channel top and flange stiffeners. The main hoisting mechanism is a 16-ton triplex chain block hung on the trolley and driven by a hand chain. The trolley is also traversed by a hand chain. The crane is carried upon 45-lb. steel rails mounted upon girders resting upon stone cappings set into the side walls above the window line.

MANUFACTURE OF ELECTRO-STEEL IN SWEDEN.

The problem of smelting steel by electricity has for a long time attracted the attention of inventors, but recent experiments in Sweden have given very interesting and promising results. Early in 1900, an electric furnace was built at Gysinge, by Mr. Benedicks, for the manufacture of steel without the use of electrodes, and after a few experiments an ingot of steel was produced which was found to be of excellent quality. The problem was not, however, solved economically; for, with the dynamo of 78 kilowatts capacity used, not more than 575 lbs. of steel were obtained in twenty-four hours, and in the furnace there was not room for more than 176 lbs. A larger furnace was completed in November, 1900, and proved to be a great improvement.

Engineer F. A. Kjellin said that the steel produced is of superior quality and characterized by strength, density, uniformity, toughness, and the ease with which it can be worked in cold, unhardened condition, even when containing a very high percentage of carbon. Compared with other steel, it also has less tendency to crack or warp when hardened.

The reason why this steel in certain qualities differs from other steel, especially in its softness when unhardened, is considered to be its freedom from gases. The manufacture of special steel, with nickel, chrome, manganese, or wolfram, will, of course, not meet with any difficulties. The chrome steel and wolfram steel produced at Gysinge has proved to be excellent for lathe tools. When used for permanent magnets, the Gysinge wolfram steel has been found to give stronger magnets than other wolfram steel and has not warped in the hardening.

From estimates made, it has been ascertained that the furnace used at Gysinge, which is simple in construction and easily managed, has prospects of competing, as to cost of operation, with the furnaces heretofore used for fusion of steel, especially as it yields steel of a better quality. If it proves commercially successful this method of smelting steel will become of great importance in the United States on account of the large supply of good ores and available water power.

LOCOMOTIVES USING SUPERHEATED STEAM.

By G. Lentz,
Civil Engineer, Dusseldorf, Germany.

About ten years ago Mr. Wilhelm Schmidt, C. E., of Wilhelmshohe, near Cassel, Germany, began the employment of superheated steam in steam engines of all kinds, and several years ago applied it to locomotives. We now have some hundreds of stationary engines in Germany working with superheated steam, giving excellent results in economy of coal and water.

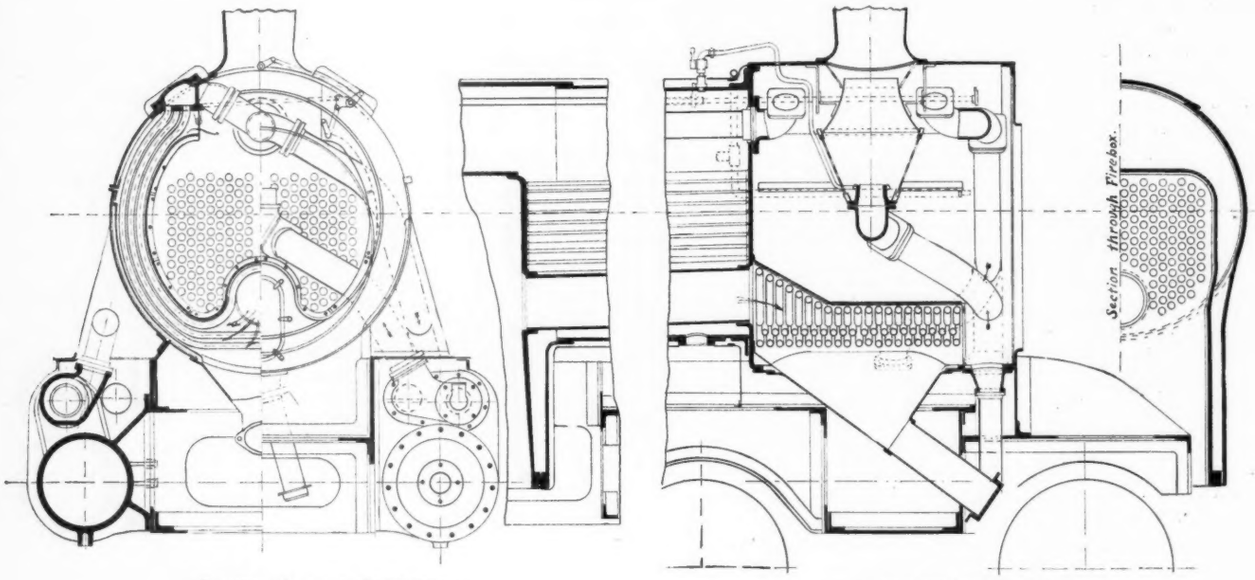
It is astonishing that it took so many years to get to a point where the advantages of dry steam are understood. But in former years it was impossible to use superheated steam in cylinders because of a lack of suitable lubricating materials and apparatus. It was customary to use animal or vegetable oils and fats which were not adopted to resist the high temperatures. They decomposed at 400 deg. F. and interfered with satisfactory operation of the engines. By using mineral oils with points of inflammation above 700 or 800 deg. F. this trouble was overcome and steam superheated to 600 deg. may now be used without difficulty. With a low degree of superheating, to 450 or 500 deg., a saving of 15 to 20 per cent. in cost is effected.

The rapid destruction of stuffing-box packing by burning constituted another drawback, as these packings mostly consisted of vegetable materials which could not resist the high temperatures of superheated steam. However, since the universal introduction of metallic packing there has been no trouble of this kind, and asbestos packings give good results with very high temperatures in engines not having metallic packing.

Another important reason for the want of success in the earlier efforts to use superheated steam consisted in the lack of suitable superheating apparatus; the superheaters required too large a space and gave insufficient degrees of superheating. All of these disadvantages acted together to balance the well known advantages of superheating and hindered its practical introduction until Mr. Schmidt solved all of the difficulties with perseverance, and he is now busy with the introduction of his system for locomotives. In Germany we have now some dozens of locomotives in service with it and some are also in course of construction in other countries.

A superheated steam locomotive was exhibited at Paris in 1900 by the locomotive works of Borsig, Berlin-Tegel, and in the current year one is exhibited at the Dusseldorf Exposition by the Hohenzollern Dusseldorf-Grafenburg. This engine has been in service for some months and has given excellent results.

In order to properly understand the value of superheating steam it is necessary to make clear the principal difference between superheated and saturated steam. Saturated steam is produced directly from water and no heat can be taken from it without the condensation of a part of it. Superheated steam is, on the contrary, a gas from which a part of the heat may be taken without transforming any part of the steam into water by condensation. For instance, saturated steam of 200 lbs. pressure has a temperature of 387 deg. F. If it loses 175 deg. its pressure becomes zero lb.. but if steam of 200 lbs. pressure is superheated to 600 deg. and it loses 175 deg., its pressure remains at 200 lbs. and 38 deg. of superheat also remains. If, however, it loses these 38 deg. also, the steam becomes plainly saturated and any further loss of temperature is accompanied by a condensation and loss of pressure. In using saturated steam a part of this is lost in the form of heat transmitted to the steam piping and by condensation in the cylinders. This condensed steam not only gives no work, but it has a damaging effect in the cylinders. In the use of superheated steam the unavoidable losses in the piping and cylinders are taken from the superheating. The steam remains not only free from condensation, but it will be still superheated to a certain degree, so that the steam retains its full pressure during the stroke of the piston.



Section through Smokebox. Longitudinal Section.

The Schmidt Locomotive Superheater.

These advantages of superheated steam are seen to better effect if it is considered that the expression "saturated steam" is generally only a theoretical one, as steam boilers always produce a mixture of steam with more or less water. This in the superheater is first changed into the saturated steam and afterward into superheated steam. The principal differences between wet and superheated steam are as follows: The steam from the boiler enters the piping in the wet state, is partially condensed here and enters the cylinders, where a further condensation takes place. It therefore acts on the piston at reduced pressure after it has lost part of its force by condensation. These losses often amount to more than 20 per cent. Superheated steam merely loses a part of its superheated temperature. A further advantage in superheating consists in the enlargement of the volume of the steam without increasing the pressure. In superheating from 180 deg. F. the increase of volume is about 25 per cent., so that 1 lb. of

steam at 85 lbs. pressure which has a volume of 27.5 gallons in the saturated state becomes 35 gallons when superheated. The influence of the steam passages and clearances at the ends of the piston stroke will be, as a matter of course, diminished in proportion to this increase of volume. This increase of volume has a great influence on the excellent results gained by superheating, which is important in large works, in the reduction in the number of boilers; in a locomotive its effect is to reduce the necessary amount of heating surface. The gain by superheating in the matter of fuel consumption averages about 20 per cent., which corresponds to a reduction of the number of boilers or amount of heating surface required from 5 to 4. A boiler with superheated steam may be worked much harder than one without it, because the disadvantages of carrying water over with the steam under forced working are overcome by superheating. For this reason three boilers with superheaters are fully sufficient where four hard worked boilers are necessary without it. This is equivalent to a 25 per cent. reduction in heating surface. With normal working the proportion of reduction of the boilers is very often equal to 3 to 2, or 33 per cent. This point is very important with reference to the cost of plant, as often the expense for superheaters in a new plant is covered by the reduced cost of boilers and buildings. The steam piping may also be reduced in diameter on account of the greater fluidity of superheated steam.

For the arrangement of superheaters the following are points of importance and should be given careful consideration:

1. The superheater must be able to superheat the steam without difficulty to 600 deg., and even more.

2. In order to facilitate its arrangement it must occupy little space, so that the maximum heating surface may be concentrated into the minimum space.

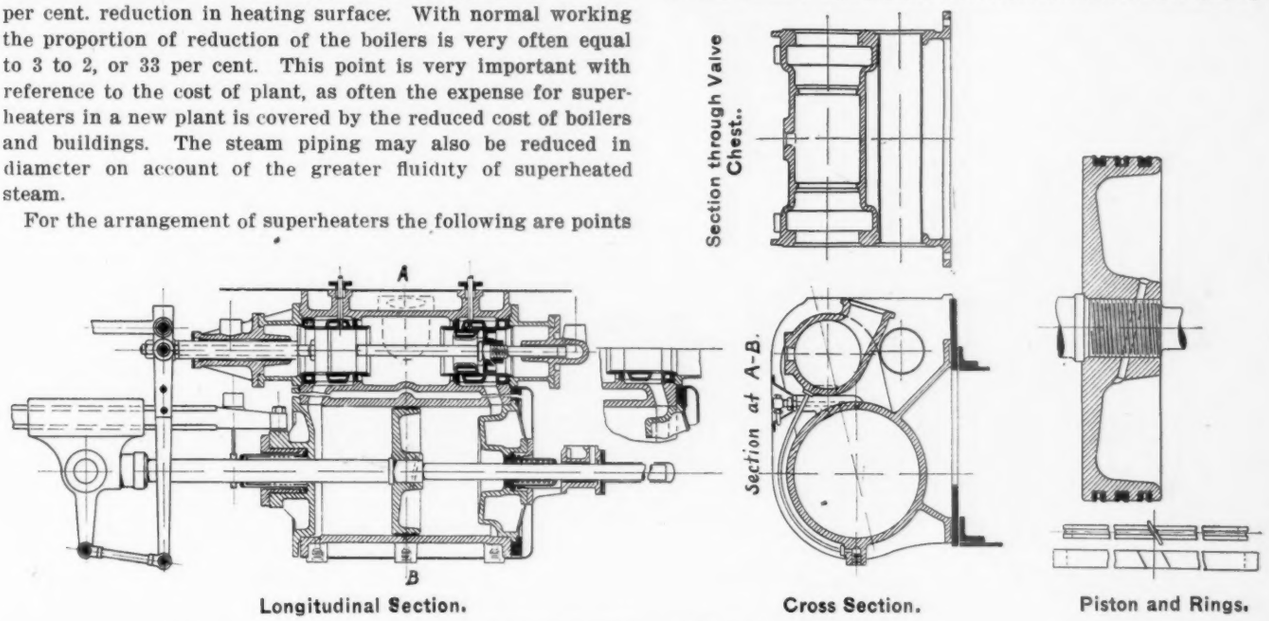
3. It must have sufficient material to be independent of changes in temperature during the process of combustion. The superheater must act like an accumulation during the time when fresh coal is put on the grate.

4. It must be so constructed as to be applicable to different kinds of boilers.

5. It must be absolutely safe in service and very durable in order to avoid annoying interruptions of service for repairs.

Mr. Garbe, of Berlin, general locomotive superintendent of the Prussian State Railways, was the first railway engineer to fully appreciate the value of Mr. Schmidt's system of superheating, and he was the first to plan its application to locomotives for different services. The locomotive exhibited at Paris was an express engine with 4-coupled wheels and a 4-wheel truck, after the type of the Prussian standard express engines, and it worked in regular service. A lot of these engines will presently go into service. The engine exhibited at Dusseldorf is a passenger and freight engine with 6-coupled wheels, for mountainous roads, heavy trains, sharp curves and high speeds. This engine has been in constant service for several months and has produced 1,200 horse power running at 56 miles per hour. The superheater is placed in the smokebox, according to Schmidt's patent. In order to run easily through sharp curves the leading and front coupled axles are combined in a 4-wheeled truck, according to Krauss' patent. The superheating is carried to 600 deg. in a system of tubes in the smokebox. Practical service has proved that the heat produced from the coal consumed was greater and the consumption of water less than in ordinary locomotives. The cylinders have piston valves with central admission, and they are lubricated by a central pump. The engine has the Schliefer air brake, a patent smoke consumer, steam heat attachment for cars, Pintsch lighting, a speed indicator and air sand blast. Its chief dimensions are:

Cylinder	20½ by 24¾ in.
Driving wheels	61 in.
Leading wheels	39⅜ in.
Wheel-base, fixed	78¾ in.
Wheel-base, total	252 in.
Heating surface, firebox	126 sq. ft.
Grate surface	24 sq. ft.
Heating surface, total	1499 sq. ft.
Heating surface, superheater	365 sq. ft.



Longitudinal Section. Cross Section. Piston and Rings.

Cylinder of Locomotives Using Schmidt's Superheater.

Steam pressure	170 lbs.
Weight on drivers	99,200 lbs.
Weight in working order	129,190 lbs.
Wheel-base of tender	130 in.
Tender tank capacity	2,750 gals.
Tender coal capacity	11,000 lbs.
Tender weight in service	75,500 lbs.

For the superheater a flue of usually 11 or 12 ins. in diameter is placed in the bottom of the boiler barrel between the tube plates, leading a great quantity of the firebox combustion gases to the smokebox, surrounding the tubes of the superheater in the smokebox.

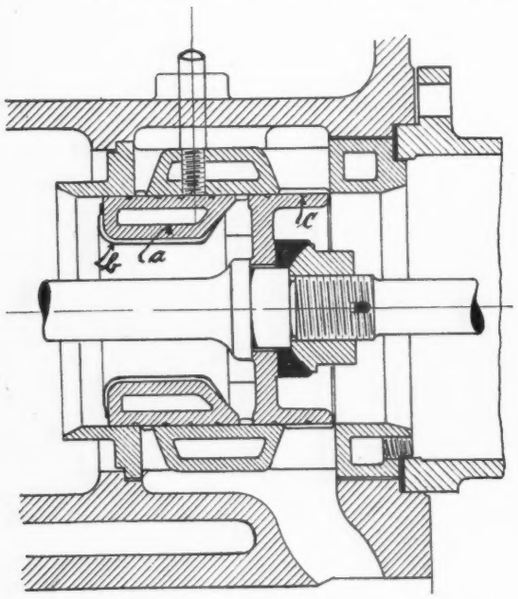
At the present time we have a great variety of wet steam locomotives on the Prussian lines, and relay (double-header) engines are necessary and are very costly in service. It is therefore of the greatest importance to have engines of greater power for high speed as well as in freight service. By using superheated steam the variety of locomotives may be greatly reduced and all engines may have two equal cylinders and not four compound. The reason that no superheating compound engines have been tried is that the complication necessary in reheating the steam after it has worked in the high pressure cylinder, as in stationary practice, would be prohibitive.

In locomotives the superheater generally consists of 60 or 70 tubes of 1¼ to 1⅜ ins. inside and 1½ to 1⅝ outside diameter, bent to conform to the smokebox sides so that they form three concentric rings. These tubes are rolled and tightened into two long steam chambers, one at the right and the other at the left of the stack opening. The inner surface of the superheater

corresponds to the shape of the outermost rings of tubes and rises to the right and left hand sides in the smokebox, to the top of the exhaust nozzle, and the whole superheater is enclosed in a cast iron box which is closed at the top by narrow valves which may be operated from the cab.

The right hand steam chamber is divided in the middle by a partition. In the rear half the wet steam enters and passes through the rear ten three-fold rings and enters, dried and partially superheated, into the left hand steam chamber which has no partition. From here the dried steam returns through the three-fold rows of tubes of the superheater to the front portion of the right hand steam chamber and passes through the steam pipes to the valve chests well superheated.

The gases diverted into the large flue to the arched space in the smokebox flow, by induced draft, through the superheater valves because of the vacuum produced by the blast acting through the stack. The stream of hot gases around the superheating tubes is proportioned to the work done by the locomotive and is nearly stopped when the throttle is closed. This



Longitudinal Section of Schmidt Piston Valve.

stream may also be regulated by means of the superheater valves. The shape of the superheater walls is such that they cannot easily accumulate too much heat and become red hot. For the protection of the superheater the blower arrangement is combined with the regulation of the valves so that the valves are closed when the blower is working.

The loss of temperature of the combustion gases from entering the boiler flue to the entrance to the chimney is about 1,450 deg., which is sufficient to heat the wet steam, during a long run of the engine, from 310 to 560 deg. According to measurements of temperature in the superheater the mean temperature was 1,230 deg., the temperature of the exit gases being 600 deg.

The lower rows of the superheater tubes are placed so far apart that the ashes entering through the large flue drop into the ash pit placed below the smokebox, and experience shows that the spaces between the superheater tubes are not blocked up. If, on the other hand, the tubes are placed too far apart, the space for the combustion gases becomes too large, the hot gases are too much thinned and give too low a superheating effect. The loose plates in the sides of the superheater box permit the inspection of the superheating tubes. From time to time the accumulated soot upon the superheater tubes is blown off by a steam jet, operated from the cab. The whole arrangement of the superheater requires but little enlargement of the diameter of the smokebox. The second ashpit is for the ashes drawn through the boiler tubes into the smokebox, and these are from time to time wet down by a steam jet.

The cylinders of the locomotives are as simple as the superheater. The piston valves with central admission give a natural balance of pressure and avoid subjecting stuffing boxes of the valve chest to high pressure. The valves of these engines can be moved easily by hand under full boiler pressure and the link motion parts can be made much lighter than usual and give long life in service. The stuffing boxes designed by Mr. Schmidt have proved their durability at the highest speeds. The working of the piston rod is cool and nearly frictionless, because of the flexibility of the packing and the tightening devices which are placed very far out and made of a lead-antimony composition. The cylinder piston is of the old Swedish type, with three light piston rings, ½ by ¾ in. in section, which do not carry the weight of the piston, but are pressed against the cylinder walls by the steam. Each ring has in the middle a light groove into which some small radial holes lead from the outside to the inside, so that wnen the piston is in its end position steam presses the end ring together and enters into the space beneath the ring and tightens the middle ring against the cylinder walls. It has been proved on an engine, which had been in regular service for some time, that this actually takes place.

After trying different piston valves Mr. Schmidt found the one here illustrated to be the best. The ring, a, is heated by the entering superheated steam and expands a little. The valve is protected against the heat of the steam by a clothing, b, of thin steel plate. In addition the piston valve is cooled on the outside by six small grooves, c.

In a nine days' run of two passenger trains over a distance of 104 miles and back in which the trains had a total weight of 794,000 lbs., a comparison was made between 8-wheel passenger engines with 4 wheels coupled, of the same type and weight; two of them were compound engines with ordinary steam and one was a simple engine with superheated steam. The engines with ordinary steam used from 37.82 to 38.24 lbs. of coal and 27.8 gallons of water per train mile. The engine with the superheater used 34.13 lbs. of coal and 20.61 gallons of water. The compound engines, therefore, averaged 11.5 per cent. more coal and more than 30 per cent. more water for the same work done. Furthermore, it is to be remembered that the engine with the superheater was built two years ago and did not represent the best experience up to date. This engine showed marked success and ran very quietly and easily at speeds of 70 miles an hour with driving wheels 78 ins. in diameter.

The following summary presents the advantages in the use of superheated steam:

1. With the superheater it is possible to greatly increase the power of an engine, without enlarging the boiler, and avoid using double-headers.

2. Both for the lightest service, running an engine over the road light, and the heaviest service, which exhausts the capacity of the boiler, the consumption of fuel and water of a 2-cylinder simple engine with superheater will be less than that of a 2 or 4-cylinder compound with saturated steam.

3. In using saturated steam the number of types of locomotives required is always great, but it may be considerably reduced by using superheaters and the details made more uniform, reducing the cost of the engines and the cost of maintenance.

4. Superheaters render it possible to reduce boiler pressures to 140 lbs.

5. Short tank engines, which are very convenient in service, can be used much more generally.

6. By increasing the productivity of the boiler by overcoming the condensation of steam and through the greater fluidity of superheated steam it is easy to design simple locomotives for the highest possible speeds.

Altogether the superheated steam locomotive represents great progress in simplicity, durability and economy of the locomotive engine.

NEW SIX-COUPLED FREIGHT LOCOMOTIVES.

Prairie or 2-6-2 Type.

Chicago, Burlington & Quincy Railway.

This is the third design of this type on this road. The first put into service, early in the year 1900, were relatively light locomotives, with small heating surface (1,958 sq. ft.) and 19 by 24-in. cylinders. They had wide fireboxes, with 42 sq. ft. area of grate, and were the pioneers in the general movement toward wider fireboxes for soft coal. These engines were illustrated in this journal in April and July, 1900. They had outside journals for the trailing wheels, and the frames were offset to provide for this feature. This frame construction has been used also on the 2-6-2 type shown on page 135 of the April issue, 1901, and the 2-4-2 type passenger engines illustrated in April, 1902, and it has given excellent results in service. This experience led to the use of the same features in a new design of the 2-6-2 type for freight service, which is illustrated by this photograph. The original "Class R" gives a tractive effort of 21,860 lbs., and the new "Class R3" gives 28,300 lbs., which represents the comparative capacities of the two designs. This represents an increase of almost 30 per cent. in tractive power and an increase of over 50 per cent. in heating surface. The following ratios of Class R3 may be interesting:

Ratio heating surface to cylinder volume, 294.

Ratio of tractive weight to heating surface, 43.9.

Ratio of tractive weight to tractive effort, 4.75.

Ratio of tractive effort to heating surface, 9.24.

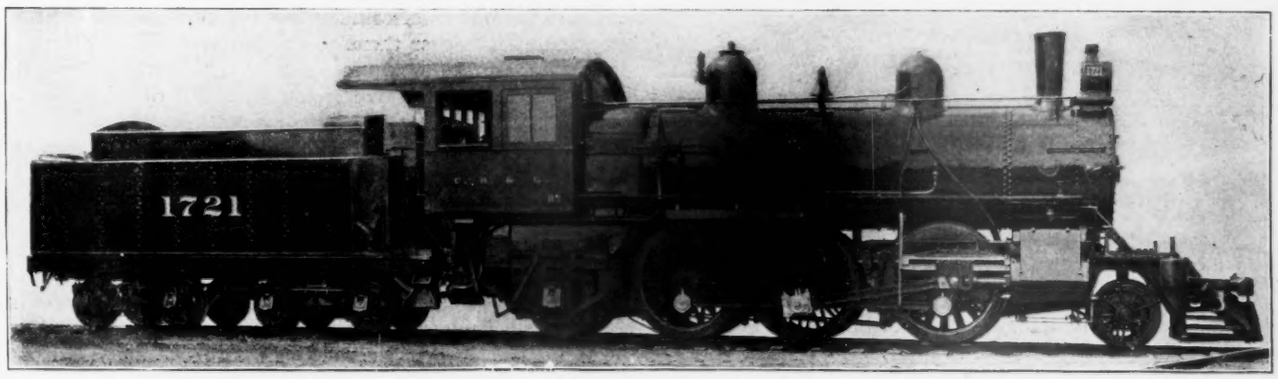
Ratio of heating surface to grate area, 72.8.

The ratio of tractive effort to heating surface, multiplied by the driving-wheel diameter, is 638, which is remarkable for a freight engine.

This design is similar in appearance to the earlier ones. The same form of Belpaire firebox, with nearly vertical side-sheets, is retained, and the details are arranged to suit the much larger and more powerful locomotive. The trailing truck boxes are like those of the passenger engine referred to, with the equalizers over instead of under the journals. The drawings present no other important changes. The following table gives the leading dimensions:

Six Coupled Freight Locomotive.
Prairie, or 2—6—2 Type.
Chicago, Burlington & Quincy Railway.

Gauge	4 ft. 8½ ins.
Cylinder	21 ins by 26 ins.
Valve	Balanced piston
Boiler, type	Belpaire straight
Diameter	65¼ ins.
Thickness of sheets	11-16 in.
Working pressure	200 lbs.
Fuel	Soft coal
Staying	Vertical
Firebox, material	Steel
Length	84 ins., width 72 ins.
Depth	Front 66¼ ins , back 63¼ ins.
Thickness of sheets	Sides ⅜ in., back ⅜ in., crown ⅜ in., tube ½ in.
Water spac	Front 5 ins., sides 4 ins., back 4 ins.
Tubes, material	Iron, wire gauge No. 11
Number 272	Diameter 2¼ ins., length 18 ft. 3 11-16 ins.
Heating surface, firebox	141.1 sq. ft.
Tubes	2919.4 sq. ft.
Total	3060.5 sq. ft.
Grate area	42 sq. ft.
Driving w. eels, diameter outside	69 ins.
Diameter of center	62 ins.
Journals	9 ins. by 10 ins.
Engine truck wheels front, diameter	37¼ ins.
Journals	5½ ins. by 9½ ins.
Trailing wheels, diameter	42½ ins.
Journals	7½ ins. by 10¼ ins.
Wheel base, driving	13 ft 0 ins.
Rigid	13 ft. 0 ins.
Total engine	28 ft. 3 ins.
Weight, on driving wheels	134,550 lbs.
On truck, ront	18,150 lbs.
On trailing wheels	29,220 lbs.
Total engine	181,920 lbs.
Total engine and tender, about	297,000 lbs.
Tank, capacity	6,000 gals.
Tender, wheels No. 8, diameter	33 ins.
Journals	5 ins. by 9 ins.



Six-Coupled Freight Locomotive, 2-6-2 Type. — Chicago, Burlington & Quincy Railway.

F. H. CLARK, *Superintendent of Motive Power.* BALDWIN LOCOMOTIVE WORKS, *Builders.*

NEW QUARTERS FOR THE NEW YORK RAILROAD CLUB.

At the meeting of the New York Railroad Club, held October 16, President Vreeland, as chairman of the special committee on new quarters, reported the very thorough search his committee had made for a suitable meeting place. The only location recommended was in Carnegie Hall, which, however, was not obtainable on the club's regular meeting night. Having thoroughly considered the matter in all its phases, the executive committee of the club recommended to the membership that the regular meeting night be changed in order to secure permanent and adequate facilities, which recommendation was approved by unanimous vote and the club will hereafter meet on the third Friday of each month, except June, July, and August, at Carnegie Hall, No. 154 West Fifty-seventh Street, New York City.

The paper of the evening at the above-mentioned meeting was: "Railway Freight Claims," presented by Mr. R. L. Calkins, freight claim agent New York Central & Hudson River Railroad. The paper was very interestingly presented and elicited an instructive discussion on the subjects of car seals, defective freight equipment, handling of freight, etc.

A superintendent of motive power, in a recent communication upon the subject of college men in railroad work, says: "It seems to me that too many young men are being developed along the line of locomotive work exclusively. I think that this is a mistake and that there is a big field opening up in car-department work. It has been my aim in bringing up special apprentices to give them a pretty thorough training in car-department work, and I wish you would advocate this practice in The American Engineer."

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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POWER PLANT AT THE COLLINWOOD SHOPS.

In another part of this issue we print a second installment of the description of the new shops of the Lake Shore & Michigan Southern at Collinwood, Ohio, taking up in considerable detail the building and equipment of the central power plant. It is not often that a power plant is to be met which involves the commendable completeness and thoroughness of detail that is evidenced in this plant, whether it be a railroad-shop power plant, or a commercial power or lighting plant. Considerable care appears to have been taken in the distribution of expenditures, in order to incorporate in the plant the great advantage not only of economy, but also of reliability and uninterrupted operation. No better evidence of this is to be had than in the mode of construction of the roof—roofs in power houses have always been a source of trouble; wooden roofs and others of a combustible nature have entailed very serious fire risks, while all metal roofs have given no end of trouble from dripping condensation in winter, but the solid hollow-tile roof at the Collinwood power house will remove both of these objections entirely. This method of roof construction is one that has for a long time been considered the best by the majority of power plant builders but has been reluctantly applied owing to its somewhat higher cost; we are pleased to see this and many other features insuring freedom from trouble introduced at Collinwood with a firm reliance on their eventual economy.

THE SHOP AS A SCHOOL.

The article on this subject in the October number of this journal was written for the purpose of setting railroad officers to thinking about methods of introducing "educated" young men to the service. The correspondence developed by it reflects the importance of the subject. Selected letters are printed in this issue and they should be read and thoughtfully studied by officers, young men and by educators who have so much influence over the young graduates.

No comment is required upon these opinions, but a summary of the most important suggestions seems desirable.

"All depends upon the man," say nearly all the correspondents. A young man's success must always depend largely upon himself, but everyone knows the importance of his point of view in starting. In this connection one says that it is a bad plan to select a number of young men to be educated for official positions. This course is a handicap to a young man.

Special privileges to college men seem to most of these correspondents undesirable and even harmful to the young men themselves, and unfair to other young men who cannot go to college. One of the letters—which is not printed—expresses the opinion that the college men, after serving special apprenticeships, invariably must rely upon the practical men to keep them out of difficulties, and the writer of the letter believes it "most unfair to discourage the practical men by putting impractical men over them." We are asked not to print this letter, and regret the request, because it would be sure to stir up a lively discussion, and it could not fail to set still more people to thinking.

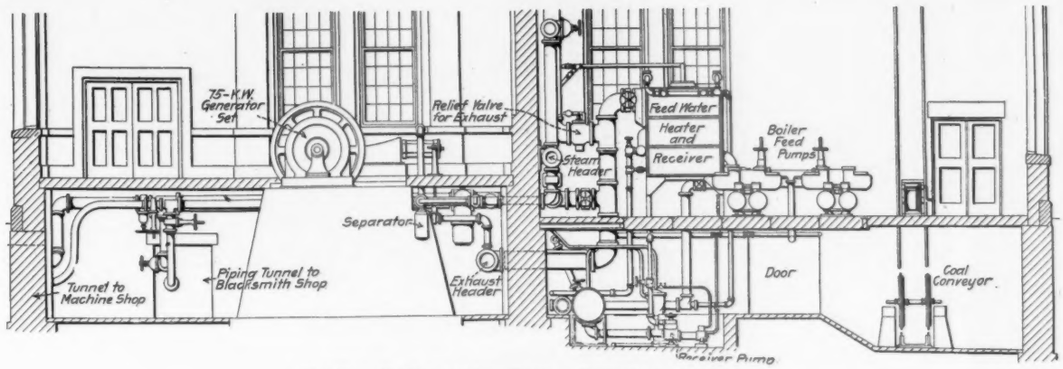
Several others are unwilling to have their names appear, and one of them gives as a reason the fact that he is ashamed to say what he believes and have the readers discover that his apprentice system is "so different."

The development of self-reliance, responsibility, the ability to direct the efforts of others and the ability to meet emergencies form the burden of the remaining suggestions received in this correspondence. There is no patent method of bringing young men up in railroad work, and no one way will fit all, but if this discussion leads even a few motive power officers to see that more time and attention must be given to the training of young men, our purpose is accomplished.

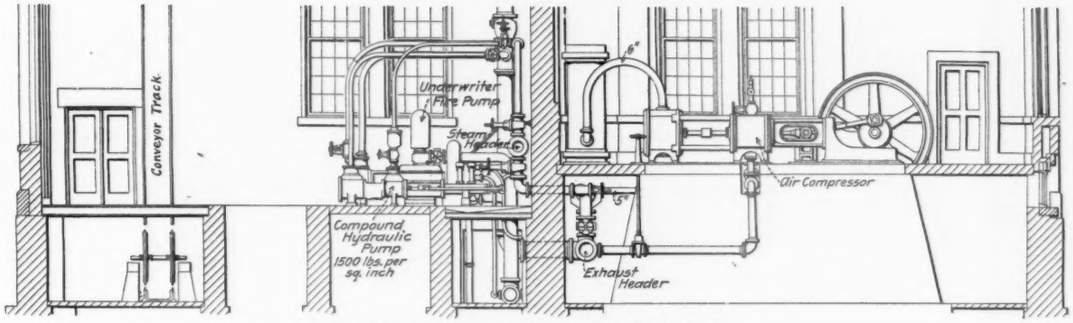
SUPERHEATERS FOR LOCOMOTIVES.

Schmidt's development of superheating in Germany has been watched with interested attention for ten years. In stationary practice he has apparently overcome the difficulties, not only in superheating, but in the use of superheated steam, and for several years has given his attention to the locomotive with promise of equal success. Mr. Lentz, who has for many years been prominently interested in the development of the locomotive in Germany, has prepared for our readers a statement of the present situation of superheating in that country with particular reference to its application to locomotives. Being on the ground, he is in position to know the facts and is believed to be an impartial observer. According to his review of superheating, this principle offers advantages which promise great things for the locomotive and which, if the necessary additional complications of construction are to be overcome as easily as he states, will put the advantages of the compound system into the background.

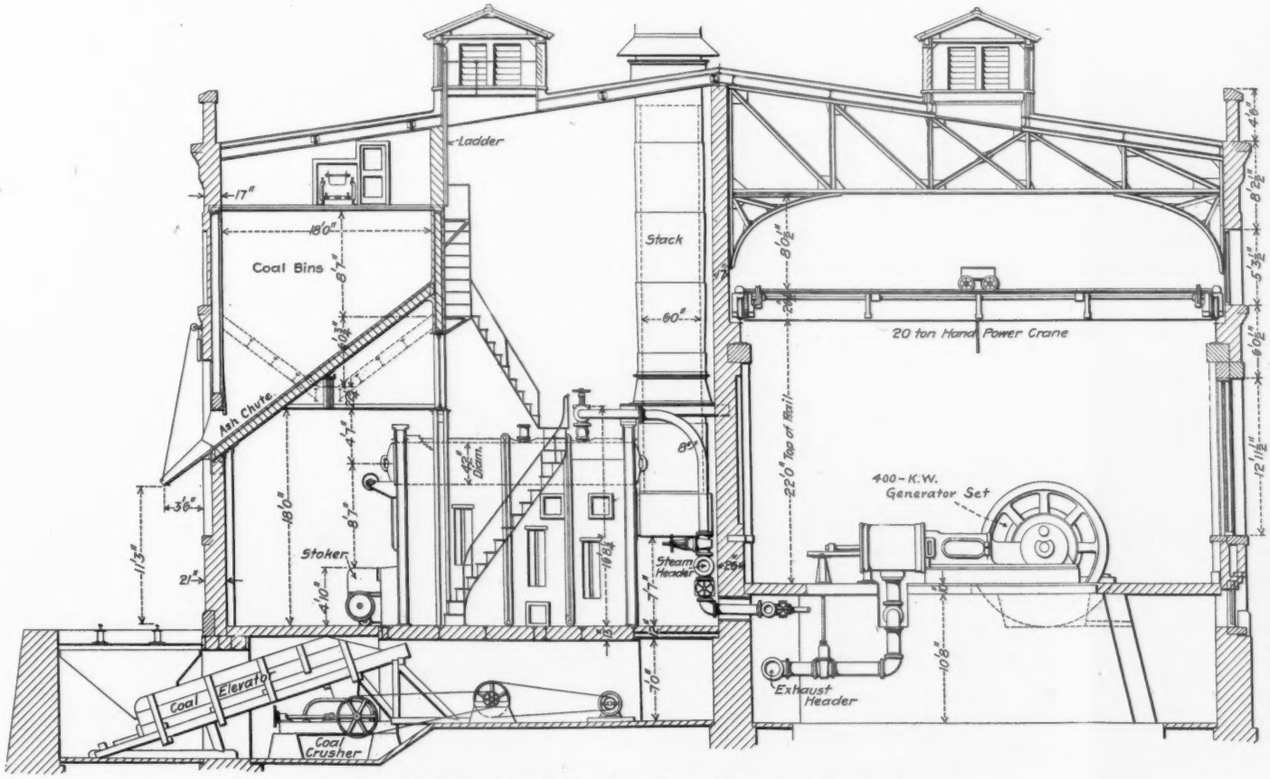
Superheating has already made a good start in stationary practice in this country, and locomotive men here are not blind to its possibilities. Undoubtedly the subject will be thoroughly investigated and exploited in this country. Superheating should have the best attention in order to ascertain its adaptability to our conditions. It promises to increase the power of locomotives, to improve economy, to provide a method of doing this with a reduction of steam pressures; furthermore, it is applicable to boilers already in use, and it



Section B-B, Looking East — East End of Plant.



Section A-A, Looking West — West End of Plant.

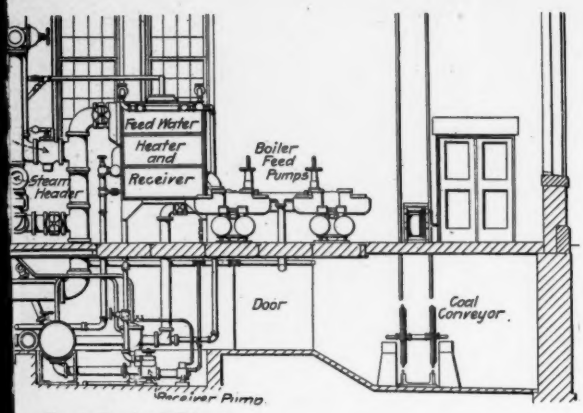


Section B-B, Looking West — Elevation of Boiler and Engine Room.

CENTRAL POWER

NEW LOCOMOTIVE AND CAR SHOPS AT COL

LAKE SHORE & MICHIGAN SOUTHER



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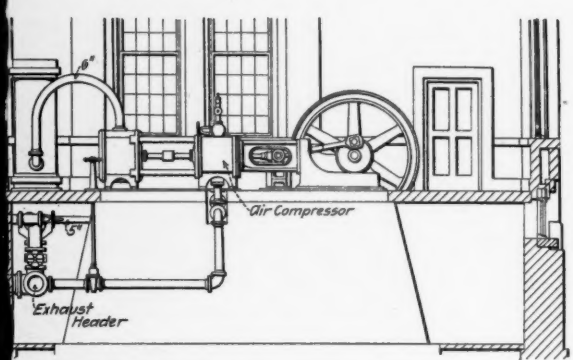

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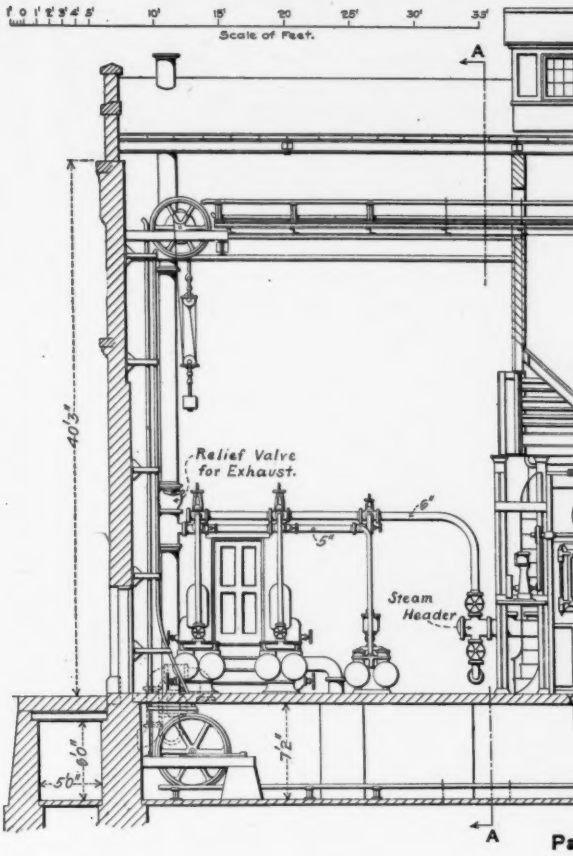

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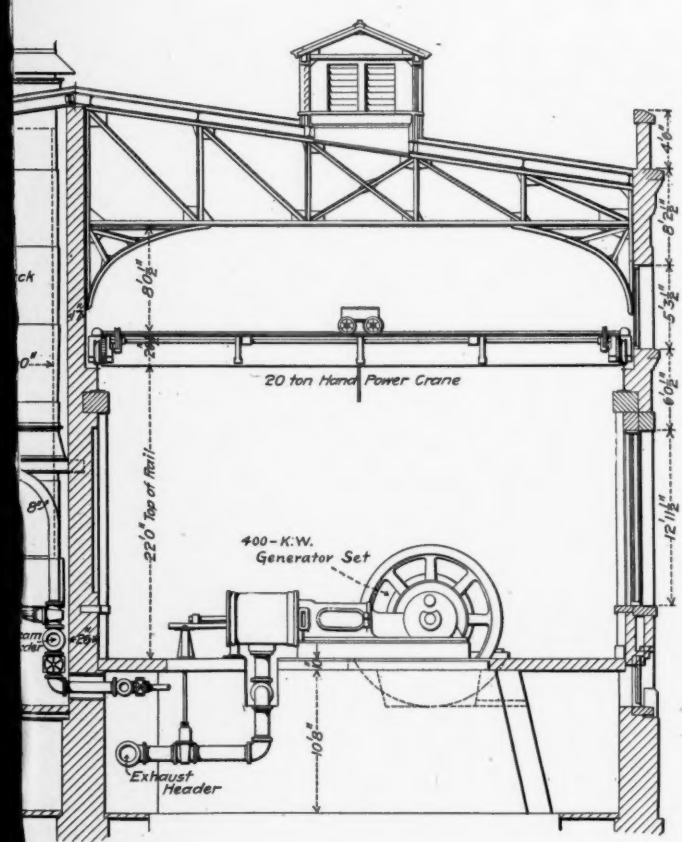

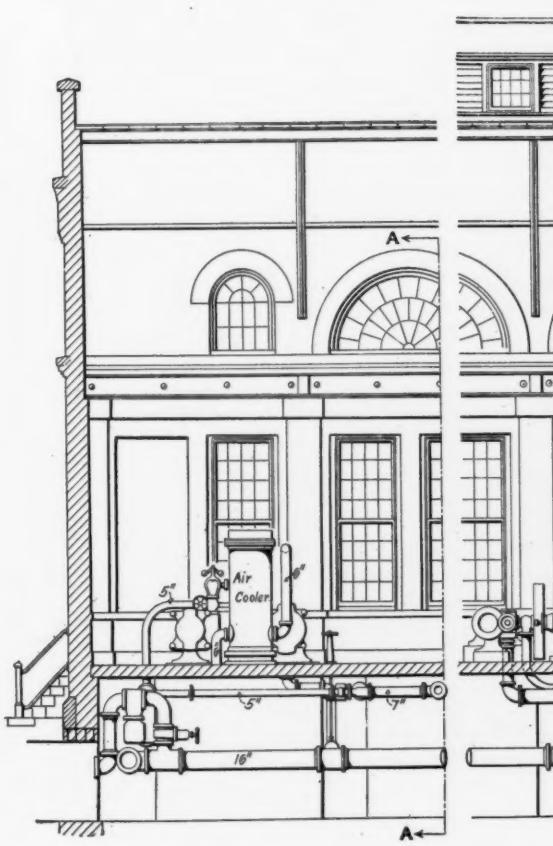

of Boiler and Engine Room.

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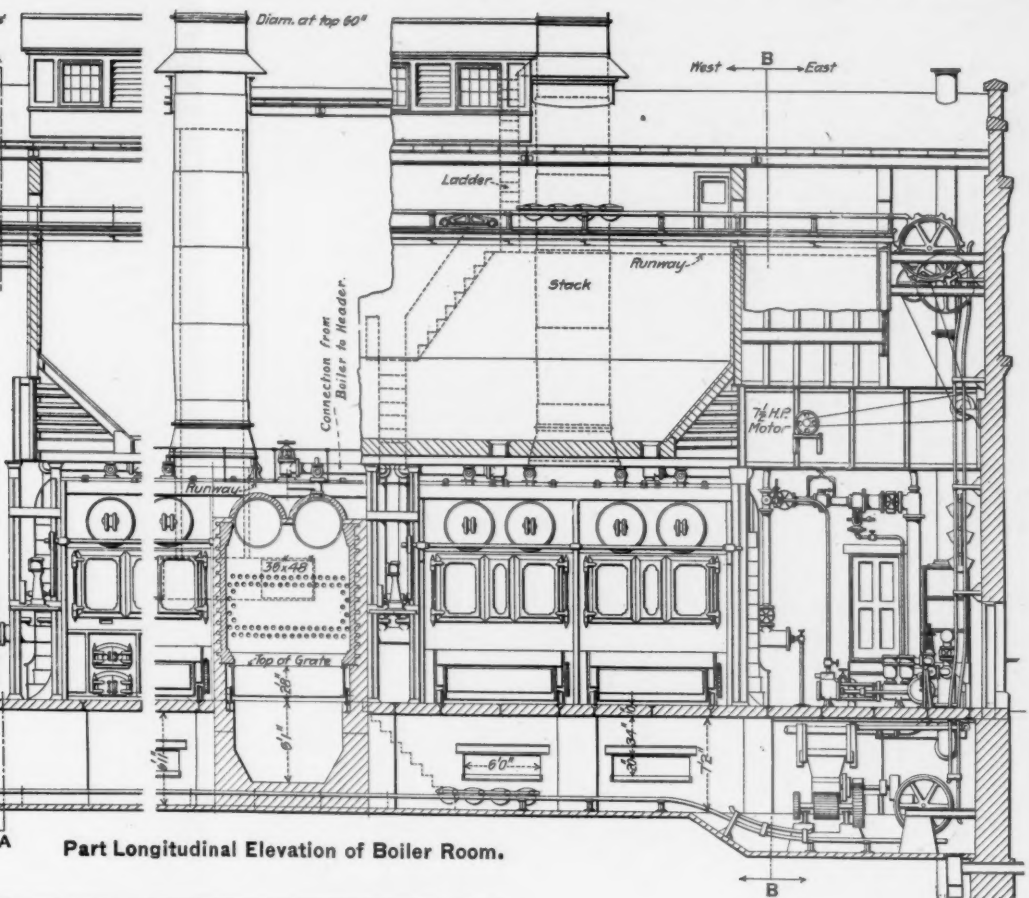
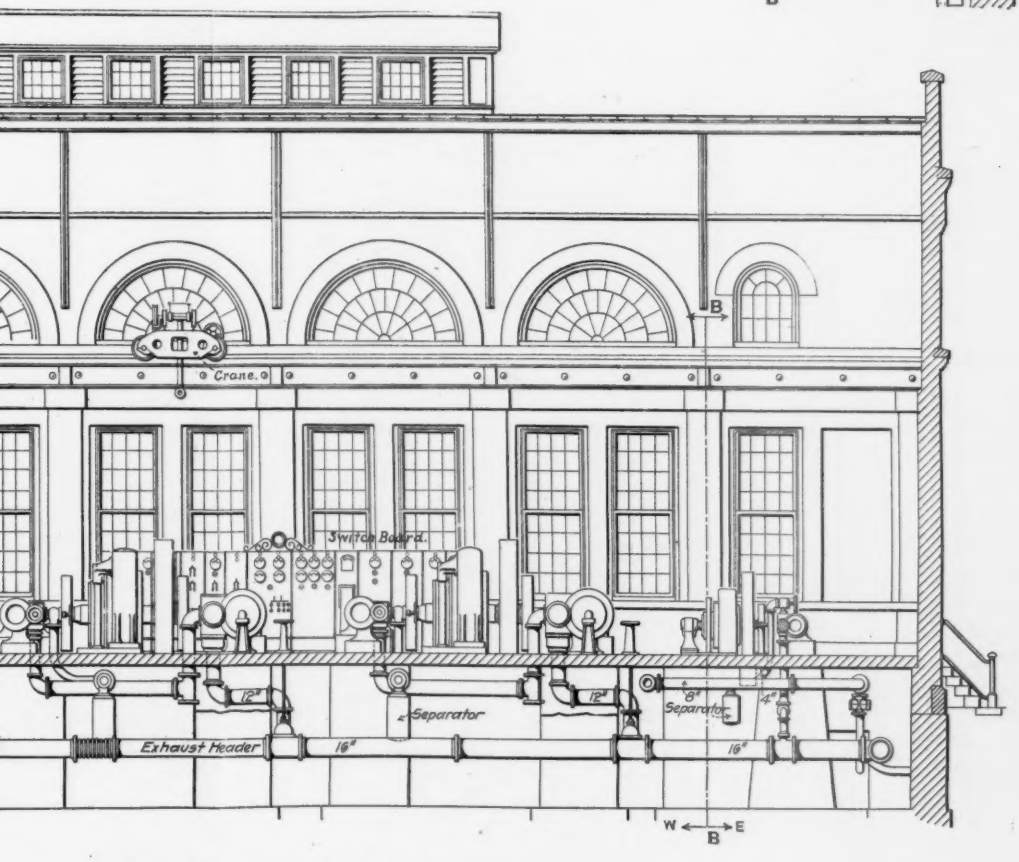
CENTRAL POWER PLANT.

NEW LOCOMOTIVE AND CAR SHOPS AT COLLINWOOD, OHIO.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



Part Longitudinal Elevation of Boiler Room.



Part Longitudinal Elevation of Engine Room.

will permit of increasing the effectiveness of relatively small heating surfaces, rendering comparatively small boilers sufficiently productive to make it pay to continue them in service. Superheating disposes of the effect of cylinder condensation which is exceedingly important in locomotive operation, more so than in any other class of steam engines. If boiler pressures can be reduced, through superheating, the item of boiler repairs and the saving of trouble with stay-bolts becomes not the least important of its advantages.

What needs to be demonstrated is the practicability of the principle in connection with our conditions of operation. Because it works well in Germany it does not follow that with our methods of pushing locomotives to their utmost service, it will be equally satisfactory here. Just what it will do here is worth knowing, and this will undoubtedly be known before long.

The superheater as described by Herr Lentz does not seem likely to meet American requirements. Such contortions of tubes filling a large part of the smokebox does not appear attractive, but there must be a better construction which will find favor here. German experience justifies any American railroad in a plan for a trial of the principle, and we should be grateful to the Germans for their admirable pioneer work in this field. They offer us a system shown to be practically successful and complete.

BRIQUETTES FOR FUEL IN GERMANY.

One of the branches of German industry which deserves the attention of Americans by reason of their economy in the recovery or utilization of some raw material which exists unused in our country is the manufacture of briquettes from brown coal, peat, and the dust and waste of coal mines. Briquettes form the principal domestic fuel of Berlin and other cities and districts in Germany; they are used for locomotive and other steam firing, and are employed for heating in various processes of manufacture. For all these uses they have three tangible advantages: They are clean and convenient to handle; they light easily and quickly, and burn with a clear, intense flame; they make practically no smoke.

The average selling price of the briquettes in large quantities was for last year $3.16 per ton, as against $2.92 per ton for the year previous. Of the 1,566,385 tons sold last year, 749,208 tons were taken by the German railways, 124,380 tons were sold to retailers, 497,136 tons were sold to factories and works of various kinds, and 149,089 tons, or 9.8 per cent., were used by German merchant steamers and the navy, or exported.

The briquettes are to a large extent made from coal screenings, which require a matrix or binder of some plastic, inflammable material, and for this purpose mineral pitch is used, which costs on an average about $10.25 per ton, delivered.

The general use of briquettes for domestic fuel in a large, densely built city, as well as for generating steam in a number of electric generating plants and factories, has a decided and beneficial influence in reducing the smoke, which in most American cities has become a persistent and oppressive nuisance. Berlin, although a busy manufacturing city, ranks as one of the cleanest and best kept in Europe. One of the first things usually noticed by American and English travelers visiting the German capital for the first time is the absence of that cloud of dusty smoke that overhangs so many towns and cities in our country. The reason for this lies in the preponderant use of coke and briquettes, which are practically smokeless.

An amusing example of British opinion of "Yankee methods" appears in the editorial paragraph from our English contemporary, *Electricity*, which is quoted herewith:

"The question of right of way through the atmosphere has just been fought out in the United States between two rival telephone companies, to wit, the North Western Telephone Company and the Twin City Telephone Company, both of Minneapolis, Minn. The former was the plaintiff, and alleged interference with its business through the proximity of the defendant company's overhead wires; the judge held that the plaintiff company, being the first in the field, had the exclusive right of way through the atmosphere between the top crossarm on its poles and a point 20 ft. above the ground level. The Twin City Company has therefore been ordered to remove its wires at intersecting points, and also from such positions as are parallel to the plaintiff company's lines on the same side of the street. *Keen business men, these Yanks; they not only want to buy up the earth, but also yearn for a considerable vested interest in the very air we breathe.*"

The changes of fifty years in machine shop practice are scarcely appreciated by the majority to-day. In a reminiscent article in *Engineering Magazine* the veteran Egbert P. Watson presents the difficulties of the days of hand work. Speaking of skilled hand work he says: "Much heavy work that should have been done on a lathe—fly-wheels and heavy gears of large diameter, for example—was done by hand on the floor for want of a tool that would swing it; and there are many modern machinists who would not care to tackle a fly-wheel 25 ft. in diameter, in six sections, chip and file all the rim joints and the arm joints where they enter the central hub, drill the bolt holes in the rim flanges, so that every part of the structure and every bolt would be iron to iron and the wheel run true on its shaft when completed, without the use of a single machine tool. Yet this is what our forebears had to do, and they did it—in the course of time."

THE RELATION BETWEEN HEATING SURFACE AND CYLINDER POWER—A CORRECTION.

We regret a typographical error in the above article appearing in our October issue; the first formula on page 314 should have read: $BD = \frac{2460\ b}{cr}$, it being identical with the last formula, No. 4, on page 315.

PERSONALS.

Mr. J. E. Muhlfeld has resigned as superintendent of motive power of the Intercolonial Railway of Canada to join the staff of the Baltimore & Ohio.

Mr. George D. Brooke, master mechanic and master car builder of the Iowa Central, has accepted the position of superintendent of machinery of the Minneapolis & St. Louis, with headquarters in Minneapolis, Minn.

Mr. B. D. Lockwood has been appointed chief draftsman of the motive power department of the Louisville & Nashville at Louisville, Ky., instead of taking the position of mechanical engineer of the Wisconsin Central, as stated last month.

Mr. T. S. Reilly has been appointed master mechanic of the southwestern division of the St. Louis & San Francisco Railway. This is a promotion from the position of road foreman of equipment, and Mr. Reilly succeeds Mr. L. H. Waugh, resigned. His headquarters are at Sapulpa, Indian Territory.

Mr. J. J. Sullivan has been appointed master mechanic of the Louisville & Nashville Railroad at New Decatur, Ala. Mr. A. Beckert retains his title, general master mechanic, with general supervision over these shops and over the Nashville and Decatur division, the South & North Alabama and Birmingham Mineral Railroads, with headquarters at Decatur.

CORRESPONDENCE.

THE SHOP AS A SCHOOL.

The following letters, addressed to the editor, were written in response to the editorial bearing this caption in the October number of this journal. These letters should be carefully read by everyone interested in young men who are taking up railroad work as a profession:

From Superintendents of Motive Power.

In answering the question propounded in your editorial entitled "The Shop as a School," in your October number, my opinion is that student No. 2 has the superior training and is much better qualified than No. 1, and for reasons which you very clearly define. Intercourse with the employees, and especially those engaged in shops, enables the observer to obtain knowledge of the individual peculiarities of the men; this important qualification is absolutely essential for subsequent work of progressive character, and it must be obtained in this exacting age. Your article is an important one and very nicely prepared; modern history certainly indorses my opinion, and yours also, I believe, that student No. 2 is better prepared to anticipate and intelligently answer the complex problems daily arising than his less fortunate brother No. 1.

T. S. LLOYD,
Superintendent Motive Power,
Delaware, Lackawanna & Western Railroad.

From my experience with technical graduates I am of the opinion that the subject of your article, "The Shop as a School," is very important. I should say that course No. 2 is decidedly the better one for a technical graduate to pursue because his ability to progress in it will prove his appreciation of the necessity for his becoming more than a mechanic, or his failure will cause him to drop out entirely.

I am opposed to the title "special apprentice" and to paying educated beginners higher wages than others, because it sets them apart in a class by themselves at a time when it is not known whether or not such distinction will ever be justified and also at a time when this distinction can do them the most injury.

I believe that the practice of starting technical graduates in roundhouses as helpers instead of in shops as special apprentices will produce better results in a given time, and I find that they are better satisfied as a rule to start in roundhouses.

The gaining of sufficient knowledge and experience to fill positions of responsibility in railroad mechanical work is a slow and not very well paid process, and the sooner a man undertakes the hardest of it and makes up his mind that he is going to stick to it for the love of it, or give it up altogether, the better for himself and his employer.

DAVID VAN ALSTINE,
Superintendent Motive Power,
Chicago Great Western Railway.

I have read the article, "The Shop as a School," and in a general way am of the opinion that fully as much depends on the character, energy, inclination and aptitude of the person as upon the conditions under which he works. Under either circumstance he would have opportunities for studying general shop conditions and learn the habits and characteristics of shop employees in addition to the trade.

The selection of a man for foreman is usually made with reference to his ability to handle men and see that they perform their full duty, together with the man's knowledge of what this duty consists of and how to perform it.

From the examples you mention it is my opinion that case No. 2 will make the better foreman.

W. RENSHAW,
Superintendent of Machinery,
Illinois Central Railroad.

You are asking a very important question of the motive-power officers of this country, and you have taken two young men supposedly of equal educational preparation, and it is also understood that they are equal in ambition and in mental capacity so far as that is possible.

Now as to No. 1: You have described his work in a manner that to say the least is mild, and he simply accepts an attractive course covering a period of three years, in which he gets a good general view of motive-power problems, and in the end he gains the confidence of the men and the officers and knows something about how the department should be managed.

In the case of No. 2 it is an entirely different problem that the young man is up against, and the way you have put it in the article will cause every motive power man and every foreman of a shop to at once say, without giving the matter a deep thought, that No. 2 is the better man, because of the fact that you have painted him in such a way as to make him overcome a great many difficulties. He overcomes prejudice and surroundings, and everything else, and he wins out in every case.

The very fact that this young man is painted in that manner will prejudice the minds of men in his favor, and that is an injustice to the first one. In other words, you have shown up what a bright fellow No. 2 is, and you don't show up that No. 1 is bright at all. No. 1 comes into the shop and starts in on the lathes. He goes to the foreman of the machine shop and he says: "I have been working on this lathe for a month and I know of a better way to do this work, and by the manufacture of some special tool I can accomplish more work and do it more cheaply than is being done by the present method." He begins to show that he is using his technical education to the advantage of the officers of the shops. The officer sees that he is a good man. He takes him away from there and puts him in another place, and true to his worth he makes other suggestions to get out of certain ruts that they have been in, and he again gains the confidence of these men, and the prejudice of the men that he is associated with is against him, but in a short time he gains their confidence, and he wins out and is placed over in another department, where by his educational facility and mechanical ingenuity, or, if you please, the simple word "fitness," he has made another victory, and has increased the output of the work very materially from what it ever had been before.

Now if you take No. 1 and carry it out on this line to its conclusion, you will place him in the same possible light before the reader that you have No. 2, and then it will be for the reader of the paper to write an article to your paper answering which of these two men is the better qualified to meet the emergencies.

Suppose there are two candidates on the platform to-day for nomination for President of the United States. Senator Depew gets up with all his oratory and sways the multitude that is before him, and every delegate feasts upon every word that he says and enjoys everything that he says, and before Senator Depew is through his candidate for the nomination, in the minds of his hearers, is the greatest man on earth.

No. 2 is likened unto another man who is candidate for the election, and "your humble servant" gets up and makes the nominating speech, and it falls so flat upon the hearers that his candidate is no good. He is dead before the first ballot is cast.

So I think in this case that the description, while it is all right, is in favor of No. 2, and No. 1 is dead before the paper is read through.

R. QUAYLE,
Superintendent Motive Power,
Chicago & Northwestern Railway.

I have carefully read your article entitled "The Shop as a School" and I know you would like me to start in and cut it wide open, but that I cannot do because I agree with most all that is said.

I believe that in taking the case of the two technical graduates and starting them out on a railroad, as you have done, one as a special apprentice and the other as an ordinary man looking for a "job," is a specially good one, and it is going to have a good effect on young men who are looking for this sort of work.

In the first place, let me state, that it seems to me the second man has made a remarkable record in three years' time. For a man to go into a shop, or rather enter railroad work, on an equal basis with everyone else, and do what the second man is assumed to have done, is entirely out of the ordinary run of things; in fact, to make this record it is almost imperative that his employer should regard him as a sort of special apprentice. However, assuming that he has gone through all of this work and has done it creditably, there does not appear to be much doubt but that he is the more valuable man of the two. He has covered almost the same ground as the special apprentice, and he has covered it more thoroughly. I say he has covered it more thoroughly because to be a gang boss—also an assistant foreman of the machine shop—he must be thoroughly familiar with the work required in both capacities.

A special apprentice will hardly be in one department long enough to acquire this familiarity; but more than this, the second man has had the handling of the men which the special apprentice

has not had, and this is of inestimable value to him. If he has been successful in this he has learned how to handle men to the best advantage, and has also made them his friends. True, he may not know as much about the ways of doing the work in the boiler shop, the blacksmith shop or the car works, as the special apprentice, but he will have some little idea at least of these things. The special apprentice will not be master of any one of these crafts. Neither of these two men hope to become dependent on their skill as a blacksmith or a machinist, but they do hope to direct the efforts of skilled men, and the one who does it most successfully will be the most valuable man. At the end of three years the special apprentice has had no experience in directing the efforts of others, while the other man has had this experience, and had been successful in it. I believe on this account that at the end of three years the second man is the more valuable one. This does not necessarily say, however, that he will continue to be so. The special apprentice may in the long run prove himself better in an executive position.

Let me say again that it is my belief that it would require a man of extraordinary ability to do in three years what the second man did, without being favored, and that under ordinary circumstances would not be done.

I have thought about this matter a great deal in the last few years, and it has been my privilege to have assisted quite a few college men to better positions, and I have never been sorry for having done it. I write this as one who did not have the advantage of a college education.

From what I have written you will judge that I have never been able to decide definitely which is the best way to start out, but I am inclined to favor the second method. However, after all is said about either course, it often seems to me that it finally simmers down to the old proposition—*it depends upon the man.* In this same connection, permit me to say that if it had never been my privilege to have talked with you on this subject, I can read between the lines that you also favor the second man.

One point in the article that strikes me as being especially good hard sense, and something that a young man can follow up and get the best results from, is that in which you say, "He boards with the men, eats at their table, and really lives among them." That is the real meat in the cocoanut. The trouble with most of these young fellows who start out as special apprentices is that in nearly every case they want different surroundings than those of the men with whom they are daily associated. They do not learn how the workingman lives, what are his pleasures, and what pleases and displeases him, and until they learn that they do not know how to handle him, and that is the reason of so many failures of special apprentices.

R. D. SMITH,
Superintendent Motive Power,
Burlington & Missouri River Railroad.

The editorial in the October number of your journal is well calculated to bring forth some excellent suggestions and criticisms from various men who are well qualified to handle questions of this kind. In my opinion, No. 2 will be the best qualified man for roundhouse foreman or master mechanic after having gone through the experience outlined, although you have pictured the most adverse conditions for him. The special apprentice, as a rule, receives special consideration and favors, and this, in many instances, prevents him from acquiring valuable information and experience that he would necessarily have to acquire were he working his way on his own merits. He therefore falls just that much short of a complete or finished education from a practical standpoint, and no matter how polished or finished he may be from a purely educational standpoint, if he is still lacking in the necessary practical experience it will develop itself in various ways when he assumes the more responsible positions. This will be particularly noticeable should his lines be cast with new roads where there is lack of sufficient power to move the business, sufficient shop facilities to maintain the equipment, and the man in charge is daily thrown on his own resources, so to speak, and compelled to work out and solve problems in surmounting difficulties that could not ordinarily be overcome by a man who had not a thorough practical training.

In my wide range of experience I have been a fairly close observer of conditions and results, and I personally know of some roads to-day which have hundreds of thousands of dollars invested in motive power and equipment, much of which is poorly designed, on account of lack of a technical education on the part of the designer; while, on the other hand, there are some striking instances of heavy losses being sustained on account of lack of the necessary practical experience of the individual in charge. There is a happy medium between the two extremes, and it seems to me that the best man for a railroad company is one who has the widest range of knowledge of things in general.

There are many men who would not be qualified to superintend the motive-power department of a railroad, no matter if they spent ten or fifteen years in college and a corresponding amount for tuition; while, on the other hand, there are many practical men who are not qualified to advance beyond a shop-foremanship. Every dollar earned for a railroad company is earned by its locomotives, and a man to superintend the motive-power department should be a railroad man in the broadest sense of the word—well up on transportation matters, and with a thorough knowledge of human nature; a good executive officer, as there are intricate problems in connection with the labor question nowadays which, if not handled properly by the head of the motive-power department, will seriously affect the earning power of the property.

The experience outlined for young man No. 2 will produce a man closely in touch with his fellow-men and in many instances fit him for handling men, organizing shops, and securing the greatest possible degree of loyalty to be obtained, not only from the shop men but the road men. The man who has not had this experience either stands aloof from the men or they stand aloof from him, and while it may not be apparent to all, it can easily be seen by those who, from experience, are competent to judge, that the lack of a cheerful response to duty on the part of the different employees of the department, if measured in dollars and cents, would make quite a difference in the cash balance of the annual report.

W. E. SYMONS.
Mechanical Superintendent,
Gulf, Colorado & Santa Fé Railway.

From Mechanical Engineers.

You ask a vitally important question in your editorial in the October number of The American Engineer. You raise the question whether we are encouraging technical-school graduates to enter railroad service in the best way, and I must say the problem has never presented itself in this way to me before. I will not attempt to answer you, except to say that I had not realized the weakness of the special-apprenticeship system with reference to the lack of executive responsibility. The fact is that a boy is too old to "begin" after he has completed a three-years' apprenticeship course on top of his college years. He needs to get at once into contact with responsibility, and that is what makes men. It all depends upon the man, after all is said, but I believe the college professors ought to use their influence toward leading graduates to see the importance of executive experience at an early point in their careers. They all want to be mechanical engineers, when foremen are most needed.

A. B. C.

The subject which is considered in the article entitled "The Shop as a Schoool" is an interesting and an important one, but because it is treated hypothetically it is very easy to find more than one side to it. It would be interesting to watch the progress of boy No. 2 transposed to the position of boy No. 1, and to see how soon he would gain the position of the man who started him in the school or gain a similar position elsewhere. I think that boy No. 2 is an exceptional one and would make an exceptional record under any conditions.

My understanding of the article is that boy No. 1 carries around on him, probably unwittingly, a placard on which the men read, in large letters, "I Am the Coming It," and so that they may have in after years the pleasure of telling how they "rubbed it into It" when "It" was an apprentice, they all "take a shy" at the placarded apprentice. If some course can be pursued which will not result in the printing and the attaching of the placard, such a course is to be preferred.

It may be possible at the present time to select each year a number of boys, tell them that they are to be trained for official positions, and to actually develop them to such a degree that any and every one of them can be put into some official position which they will fill satisfactorily in accordance with present enlightenment; but the theory is not a correct one, and it will be proven wrong as the demands become more exacting. At the age at which an apprentice, or a beginner, must be employed it is impossible for the

employer, or the boy either, to know whether he will develop an aptitude for the business. Some of the boys will not so develop, and therefore the employer must start a greater number of boys than he can expect to use ultimately, and some way must be provided for either side to terminate the arrangement when either side is satisfied that it cannot be concluded to advantage. This explains, also, the difference between boy No. 1 and boy No. 2 of the article. Boy No. 1 is told what is in prospect for him; therefore, if some of the work is distasteful to him, he gets over it as easily as possible, knowing that there is a predetermined time for a change, and that ultimately something must "be done" for him. Boy No. 2 knows that he must learn before he is advanced, and therefore sets himself about learning and working out his own station. If he finds that his rating is not sufficiently high to give him advancement, and he decides that he is at fault, and not the rating, he will probably find some other calling in which his rating will correspond with his own ideas. He will prosper accordingly, and no agreements will be broken.

No doubt boy No. 2 will prove to be the more valuable, but inasmuch as he is wise beyond his years, he will not seek employment where boy No. 1 is exhibiting his placard.

F. M. WHYTE,
Mechanical Engineer,
New York Central & Hudson River Railroad.

You make out a very plain case for No. 2, who shows an individuality which will conquer circumstances, and with equal opportunities he will beat No. 1 on account of his mental equipment, which he has reinforced by practical experience. Nine times out of ten the practical man will beat a purely theoretical man because his theory so frequently falls short of covering all of the conditions. He who combines theory with practice is the better man, and your No. 2 has schooled himself in management, which No. 1 has failed to do.

I have very little respect for a college man as such, and I have all respect for the advantages of a college education possessed by one who can take advantage of it. A college man coming to a railroad expects to have, in time, an advanced position. As a matter of fact, however, he is no better prepared for the detail of railroad work than any other stranger. In my opinion, it is necessary that the rules for apprentices should not be modified for a college man, but during his term of apprenticeship he should be given special work to do under the direction of the master mechanic, fitting him to take such an advanced position as the superintendent of motive power has in mind when taking special apprentices. It must be borne in mind that unless it is intended to fill such positions with college men, it would be no use to take them in unless they accept the opportunities of apprenticeship with absolutely no modification. I rather incline toward regular apprenticeship for technical-school graduates.

College education does not fit a man for an advanced position, but it will assist him very greatly if he has it in his make-up to handle men and matters which an uneducated man could perhaps do better by virtue of natural aptitude. In these things success is a matter of natural leadership, education or no education. I know of several mechanical engineers of railroads who have obtained marked success and are not college graduates. I also know college graduates who have entered railroad work and by going through regular courses of apprenticeship have fitted themselves by hard work to take advanced positions, and in these cases education has been very helpful.

There is no hard-and-fast rule in this matter. Everything depends upon the individual. I should be inclined to say to the man who is applying for special apprenticeship by virtue of his education that we have no special courses, and that if he wishes to enter upon a regular apprenticeship, all opportunities which we may have for special work will be given him, and he will then be left to work out his own salvation. If he proves to be an exceptionally good man, and by combination of his college education and his training he becomes a leader, he may confidently expect consideration when there are openings for advanced positions; in fact, we are all the time looking for such men.

S. A. C.

From a Master Car Builder.

I consider this article very important at this time, and I believe the subject is one which will be read with great interest. In answer to the question as to which of the two young men would be the more liable to succeed, I believe that No. 2 would have very much the better of No. 1, both from point of knowledge of detail and from the fact that he would have a first-class opportunity to demonstrate whether or not he would be capable as an executive.

It might be well at this time to sound a note of warning in regard to the special privileges allowed special apprentices. If we carry this matter too far, it will have a tendency to discourage the regular apprentices in the shops, who, if properly encouraged, will take up a correspondence course and acquire the necessary technical education. A great many good, practical men are leaving railroads that allow the special apprentice favors, on account of the fact that they have got the idea into their heads that no one but a college graduate will be promoted. This is a very serious matter, and steps should be taken to give everybody to understand that push and ability and close application to business will win, no matter whether a man has received his education in a college, common school, or by home study.

LE GRAND PARISH,
Master Car Builder,
Lake Shore & Michigan Southern Railway.

From Two Friends of Many Young Men.

I have gone very carefully over the article in your October number, and believe it covers the ground quite fully, but, after all, when we come to study this question of technical education of young men, I cannot but feel more and more each year that we know very little as yet about "education."

Mr. Schwab started on a grocery wagon to become president of a billion-dollar steel trust. Mr. Carnegie started in a cotton mill and graduated through the office of a telegraph operator to become one of the greatest organizers the world has ever known. Mr. Pullman started as an ordinary carpenter and died leaving as a monument one of the greatest enterprises in existence to-day. James A. Garfield started on the tow-path of a canal and became President of the United States. M. Witte, present Minister of Finance of Russia, and one of the greatest national financiers in the world, began as a railroad clerk.

Andrew Carnegie, in making answer to the following question propounded by a reporter some time ago—"What is the one great essential to success for a young man?"—said, "To be born poor." Ouida has said: "Poverty is the north wind that lashes men into Vikings"; "Adversity is young ambition's ladder."

After all, may it not be a fact that in the Divine plan there may be a specification that the best education is to have to battle with adversity early in life? All of Christ's teachings would point to this, and is it not possible that in the great economy of nature this rule must apply as a sort of leveling process? Otherwise, the chasm between those who are able to get an "education," as we usually apply the term, and those who cannot do so, would grow wider and wider, and the result would certainly be most lamentable. You know someone has said:

"If life were a thing that money could buy,
The rich they would live and the poor they would die;
But God in His goodness hath ordered it so
That the rich and the poor they together must go."

I wonder, after all, if this same rule might not apply to some aspects of our struggle here on earth.

I, of course, realize that in some quarters this doctrine is quite unpopular; possibly it is wrong, but these are thoughts that constantly occur to me, and when I come to study, page by page, the great book of events transpiring around us, I cannot always refrain from thinking that possibly we do not yet know just the proper definition of the word "education," or rather that we attach altogether too much importance to the stilted process we now term "getting an education."

C. D. E.

I have read with much interest your article, and think you have put the situation confronting graduates about to enter shop work just right. After all, he must choose for himself, and success will continue to depend on the combination of technical knowledge, energy and ability to understand and make friends of those with whom he is associated in his daily work. I think the chances of success are about even between No. 1 and No. 2; the latter, however, more likely to receive recognition first.

N. W. SAMPLE,
Baldwin Locomotive Works.

From College Professors.

I have read the article, "The Shop as a School," appearing in the October issue of The American Engineer and Railroad Journal. The shop is never a school; it is simply a shop. In a well-managed and well-equipped technical school a young man can learn more in one year about machine-tool processes and the materials of engineering than he can in any shop in three years while working as a special apprentice. In a technical school he cannot learn how to handle men; he can never know how to handle men successfully unless he has been one of the men. He must think as they think. He can never handle men anyway unless he has some traits of character which make him sympathetic, tactful, and firm. Either one of the young men referred to in the above article will be successful if he is persistent and has work thrust on him that makes him feel responsibility. If wisely looked after, the first man will eventually make the better master mechanic. The second man may make more rapid progress at first, but that would depend more upon fortunate circumstances than upon the ability of the man.

L. P. BRECKENRIDGE,
University of Illinois.

The ground you cover is very familiar, but I have never seen a better illustration than this of the principles involved. I would suggest, however, that the fundamental difference between them is that No. 2 is a *man;* No. 1 may be, but more by good luck than good management. Colleges may educate to almost any extent, but it is only when they educate a *man* that much good is done.

A noted New York financier said that he had spent $50,000 on the education of his son, and yet he could not earn his living.

I know a man who did not spend $50 on the education of his three sons, and yet they are handsomely educated and can earn a living for quite a number besides themselves.

It is singular, but I have just answered a letter of a young man asking for advice. He was graduated last year, and has just started in a machine shop at the bottom. He is dissatisfied, saying there is no room to rise, and yet he tells me of a young man who went to the same shop four years ago and is now roundhouse foreman. This latter man was like the No. 2 of your article, and will be a man who will be of some use in the world.

There is no royal road to learning, nor is there to usefulness. Those who are useful, from kings down, or up, as the case may be, obtain that capacity for usefulness by hard knocks, persistent and untiring effort. I am sending your article to the young man who is asking for advice; he needs the article right now.

I am one of those professors who do not believe that their duty ceases when the lecture-room door closes, and in consequence am constantly running across those who would find the easy road, the paths which No. 1 trod, and urging them to take the path of your No. 2. I believe the difference is not so much in what the two know, but in that far nobler trait of character—manly self-reliance. No. 1 relies on his "pull," and how many there are who spend their lives complaining that they have no "pull" and therefore cannot succeed! Every man has all the "pull" in himself that he needs, but most men are too lazy to use it. They want someone else to pull them. This takes us back to the same old principle which involves all crime and misery—we try to avoid the punishment meted out to us through Adam—"In the sweat of thy brow thou shalt eat bread all the days of thy life."

I would that there were much more published along the lines of your article.

L. S. RANDOLPH,
Professor of Mechanical Engineering,
Virginia Polytechnic Institute,
Blacksburg, Va.

From a Promoted Apprentice.

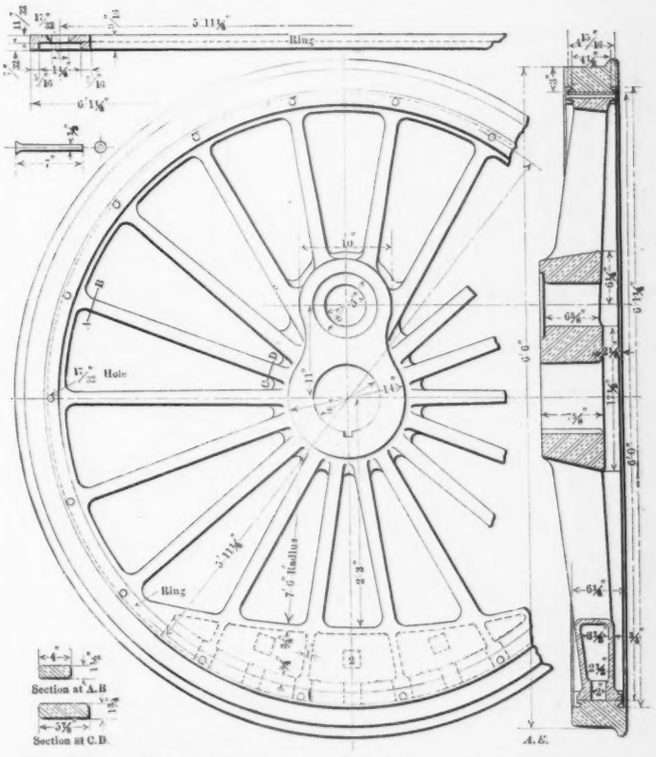
I have enjoyed reading the article entitled "The Shop as a School," and feel that you have stated the situation very well; but I think that a young man fresh from a university would consider his a most strenuous life if he put aside his recently acquired learning and went to work on his own responsibility in a roundhouse washing gang. The special-apprentice course is all right as far as it goes, but a college man should not forget his college ideas and feel that he is no better than anyone else, and he should begin where his practical knowledge allows him to begin. The comparisons you have made are excellent, and the questions raised will be the cause of setting many young men thinking. C. C. H.

CAST-STEEL DRIVING WHEELS.

Made Without Cutting the Rims.

Philadelphia & Reading Railway.

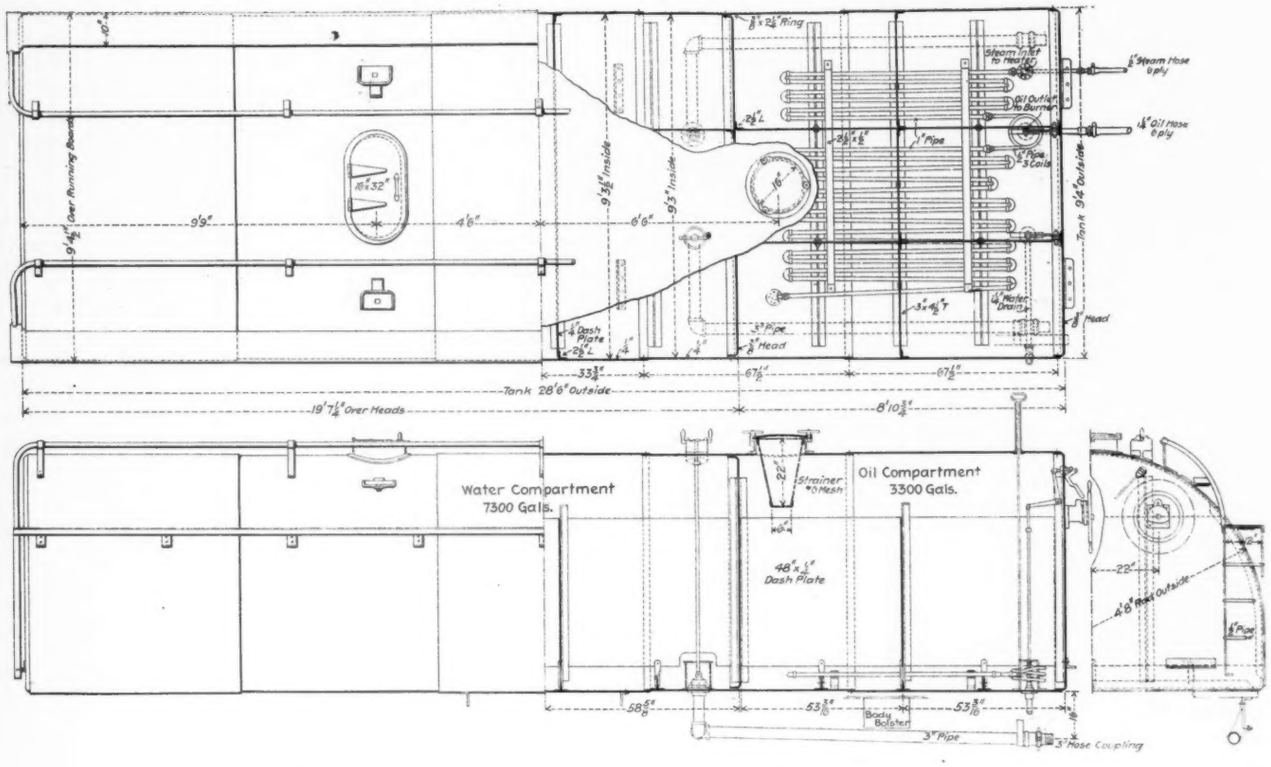
An interesting design of cast-steel driving wheels, brought out by Mr. S. F. Prince, Jr., superintendent of motive power and rolling equipment of the Philadelphia & Reading Railway, is illustrated by this drawing. With a view of overcoming the breakage of cast-steel wheel centers because of shrinkage stresses, Mr. Prince designed this pattern to be cast solid; that is, without cutting the rims. The draught is all in one direction, and the molder's work is simple. There was at first considerable hesitation on the part of the foundrymen



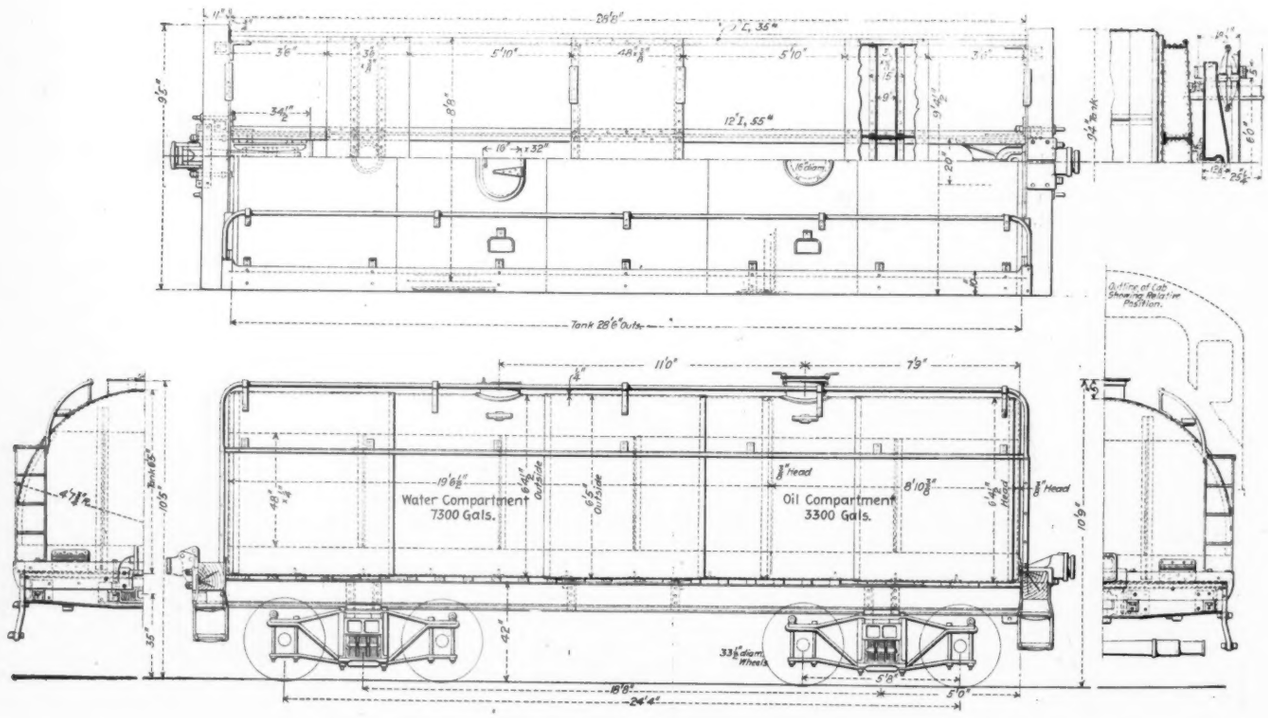
Cast-Steel Driving Wheel with Uncut Rims.—Philadelphia & Reading Railway.

to undertake the casting because of well-known difficulties with the shrinkage of the castings in the mold. Mr. Prince met this by suggesting the use of sawdust between the spokes in the mold to offer an elastic resistance to the shrinkage of the spokes. The yielding of the mold seems to meet the requirements, and wheels cast in this way are now undergoing experimental service. The construction of the wheel is clearly indicated in the engraving.

If nearly an hour is required for testing and making running repairs on the air brakes of a freight train which is made up and ready to go, and the engine must be coupled to its train for this purpose, it is easy to see an opportunity to materially increase the effectiveness of locomotive equipment in busy times by installing yard testing plants in order to save the time of the locomotives. Mr. H. F. Ball made this claim in a discussion at Saratoga in June. His conclusion was that it would pay to install these plants at all important points where trains are made up, or where cars are added, as at junction or division points.



Part Sectional Plan and Elevation of Tank, Showing Arrangement of Heater Coil



Plan and Elevations of Tender, Showing Details of Trucks, Frames, Etc.

Tender and Tender Tank for Oil-Burning Locomotives — Southern Pacific Railway.

TENDER AND TENDER-TANK FOR OIL-BURNING LOCOMOTIVES.

Southern Pacific Railway.

The use of fuel oil on the locomotives of the Southern Pacific has become sufficiently permanent and extensive to warrant the design of tenders specially adapted to the purpose of carrying oil and water. Heretofore an oil tank has usually been placed in the coal space of an ordinary tender and perhaps extended into the water space. In this case the whole tank is made semi-circular in section and divided by a partition into two sections, one for oil holding 3,300 gallons at the front of the tender and the other at the rear end for water, holding 7,300 gallons. The construction of the tanks and the tender frame is so clearly shown in the engravings on the opposite page as to render an extended description unnecessary.

At the front end of the oil tank is a coil of pipe by which the oil is heated by steam, and this coil has a loop surrounding the outlet for the purpose of facilitating the flow of oil through the valve. The valve is operated by means of a bell crank and lever at the front end of the tank. By making an attachment between this lever and the cab of the engine by means of a chain the oil valve is sure to be turned off in case the tender separates from the engine. The drawings show a strainer under the manhole through which the oil is passed into the tank.

The tenders are mounted on diamond trucks and the tender frames are of steel. The center sills are 12-in. I-beams placed 20 ins. between centers, and the side sills are 10-in. channels. The sills are tied together at the bolsters and also at the center. They are braced at the center by means of two pressed channels and also by a flat plate 48 ins. wide. These tenders are equipped with the Miner twin spring draft rigging placed between the center sills. The bolsters are built of top and bottom plates with stiffening filling pieces of pressed steel plate between them. These extend between the center and side sills and at the center a steel casting receives the center plate. The cast steel truck bolsters were furnished by the Leighton & Howard Steel Company.

SIDE PLAY REQUIRED IN CAR COUPLERS.

End Sill Clearance on Curves and Length of Safety Chains.

By Theo. H. Curtis, Mechanical Engineer, Louisville & Nashville Railroad.

Draw-bars should have sufficient side play to allow their cars to pass from a curve to straight track and return and from curve to reverse curve, without causing any binding or cramping in the side guards or in the coupler heads.

The M. C. B. contour lines permit side play to the extent of an angle of fourteen degrees between the center lines of draw-bar shanks when knuckles are locked. This angle is all that is required in most cases, when both cars are alike in wheel base, over-hang of draft rigging, etc., and both on the same curve. The angle between center lines of draw-bars, however great, does not relieve the necessity of side play for draw-bars in cars passing from straight track to a curve and vice versa, or from curve to reverse curve.

When two cars are on the straight line their draw-bars are pulling on a line directly over the middle of the track, and when the first car enters a curve, the center of face of its draw-bar at the rear leaves the middle of the track and passes toward the outside of the curve, while the center of face of draw-bar on car yet on a straight line is directly over the center of the track.

The side movement of the draw-bars in their relation to each other will be compensated for by the side play, if any, or, if bars are rigidly held; by springing both draft riggings, taking up all loose joints, etc., by pulling the car transversely of track, taking up all side play in journals, by throwing one pair of trucks to the inside of track and the other to the outside, making curving resistance very high. When all side play is taken up and still more is required some part of the draft rigging must give way, or the car is derailed.

The maximum side play required for any draw-bar can be determined without calculation, if the car in question can be placed on the sharpest curve over which it is to pass, as follows: Place the car on the curve central with the track; lay off center line of track under the draw-bar; move center of draw-bar face sidewise until same is exactly over center line of track. If every car has side play enough to permit draw-bar to come over center line of track there will be no binding, as each draw-bar needs to come only half way.

Several formulas are given below which cover general combinations of like cars in different relation to each other. For other combinations it is suggested that the formulas be used for computing each car and the respective angles they bear to each other; that a drawing be made showing the angles and the side play be measured from the drawing. The accompanying engravings represent such drawings—Fig. 1 showing two cars in a regular curve, and Fig. 2 two cars on reverse curves. Fig. 3 is a plan view of the draw-bars. Each figure has letters of reference, which letters are explained below:

a. Distance from face to draw-bar to line, f, in feet;
b. Distance from end sill to line, f, in feet;
c. Distance from center of truck to line, f, in feet;
w. Distance from center of car to end of end sill, in inches;
f. Line from center of curve to center of car between trucks;
g. Line from center of curve to center of truck;
h. Line from center of curve to face of draw-bar;
k. Distance from face of draw-bar to end sill, in inches;
l. Distance from outside corner of end sill to line, h, in inches;
m. Distance from inside corner of end sill to line, h, in inches;
n. Distance from face of side guards to pivot point, in inches;
p. Side play required at each side of draw-bar at face of side guard, in inches;
o. Distance from center line of car on curve to center line of track, in line h, in inches;
z. Distance from face of draw-bar to pivot, in inches;
x. Center line of car;
R. Radius of curve, in feet;
D. Degree of curve;
S. Angle between lines, f and h;
T. Angle between lines, f and g;
U. Angle between center lines of like cars on same degree curve;
V. Angle between center line of car and center line of draw-bar;
W. Angle between center lines of draw-bars.

EXAMPLE.

Assume a car 38 feet long, 26 feet between truck centers, 10 feet wide, 18 inch face of draw-bar to end sill; a = 20.5 feet; b = 19 feet; k = 18 inches; c = 13 feet; w = 60 inches; R = 193.2 feet; D = 30 degrees; z = 42 inches; n = 30 inches.

COMPUTATION OF RADIUS OF CURVE, DEGREE BEING GIVEN.

$\frac{5730}{D} = R$, nearly. (This formula is close enough for practical purposes.)

For correct radius of curve see Engineering Tables for radii.

COMPUTATION OF ANGLE T:

$$\frac{c}{R} = \text{sin. } T; \quad \frac{c}{R} = \frac{13}{193.2} = \text{sin.} = 0.06728 = 3^\circ\ 51'.$$

COMPUTATION OF ANGLE S:

$$\frac{a}{R \cos. T} = \text{Tan. S:} = \frac{20.5}{193.2 \times .99774} = 0.10634 = 6° 4'.$$

COMPUTATION OF DISTANCE l:

$$\{(k \text{ cot. } S) + w\} \text{ Sin. } S = l.$$

$$\{(18 \times 9.409) + 60\} \times 0.10569 = 24.2 \text{ ins.}$$

COMPUTATION OF DISTANCE m:

$$\{(k \text{ cot. } S) - w\} \text{ Sin. } S = m;$$

$$\{(18 \times 9.409) - 60\} \times 0.10569 = 11.52 \text{ ins.}$$

COMPUTATION OF DISTANCE o:

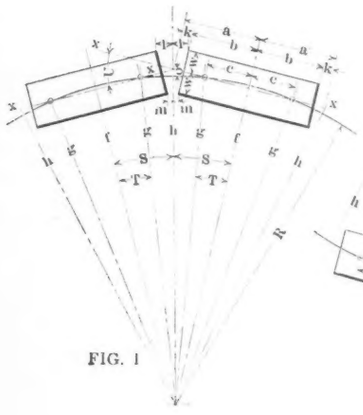


FIG. I

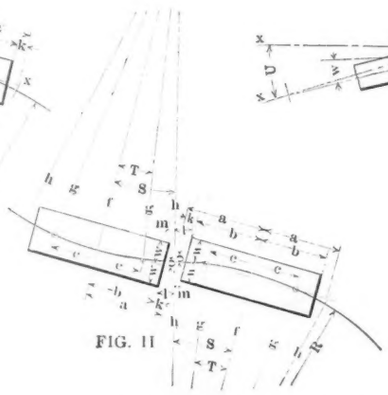


FIG. II

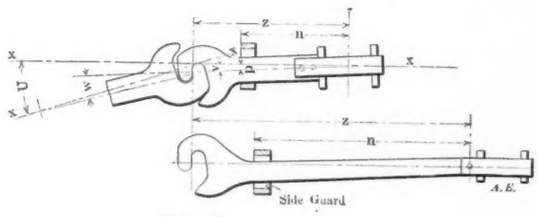


FIG. III.

Side Play Required in Car Couplers.

$$12\left[\{R \text{ (Sec. S} - 1)\} - \{R \text{ (1} - \text{cos. T) Sec. S.}\}\right] = o$$

$$12\left[\{193.2 \text{ (1.0056} - 1)\} - \{193.2 \text{ (1} - .99774) \text{ 1.0056}\}\right]$$

$$12\left[\{193.2 \text{ .0056}\} - \{193.2 \text{ .00226 } 1.0056\}\right]$$

$$12\left[1.0819 - .43913\right] = 7.725 \text{ ins.}$$

COMPUTATION OF ANGLE V, on reverse curves of same degree:

$$\frac{\{o - (z \text{ Sin } S)\}}{(z \text{ cos. S})} = \text{tan. } + S = V; \quad \frac{\{7.725 - (42 \times .10569)\}}{(42 \times .9944)} =$$

$$.0787 = 4° 30' + 6° 4' = 10° 34'.$$

COMPUTATION OF ANGLE V., when coupler is held in side guards:

$$\frac{p}{n} = \text{tan. V.} = \frac{5.5}{30} = .18338 = 10° 34.'$$

COMPUTATION OF SIDE PLAY, P:

$$N \times \text{Tan. V} = P.$$

$$30 \times .18338 = 5.5 \text{ ins.}$$

COMPUTATION OF ANGLE U, for two like cars on regular curve of same degree:

$$U = 2 \times S.$$

COMPUTATION OF ANGLE W, for two like cars on regular curve of same degree with draw-bars rigid in side guards:

$$W = 2 \times S;$$

with draw-bars having play in side guards:

$$W = 2 \text{ (S—V)}.$$

When the angle W is greater than twice the angle S (2S), no side play is required for the draw-bars, while the two like cars are both on the same curve. The maximum side play is not required when both cars are on the same regular curve, but only when they are on reverse curves.

COMPUTATION OF ANGLE V, for two like cars, one on curve and the other on straight track:

For the angle V, for the car on straight track—

$$\frac{\{o - (z \text{ Sin. S})\} \ 5.}{(z \text{ cos. S})} = \text{Tan. V.}$$

$$\frac{\{7.725 - (42 \quad .10569)\} \ 5.}{(42 \quad .9944)} = .03927 = 2° : 15'.$$

For the angle V, for the car on curve—

$$\frac{\{o - (z \text{ Sin. S})\} \ .5}{(z \text{ cos. S})} = \text{Tan. } + S = V.$$

$$\frac{\{7.725 - (42 \ .10569)\} \ .5}{(42. \quad .9944)} = .03927 = 2° : 15' + 6° : 4' = 8° : 19'$$

Two M. C. B. draw-bars should couple at about 11 degrees for angle W; this allows for roughness of the castings with respect to the contour lines. The M. C. B. contour lines will allow an angle of 14 degrees for W.

For locomotive tenders the lengths (a) and (k) must be taken to suit tender on each end. For locomotives of the four or six-coupled type, the length (c) will be one-half the distance between centers of outside driving wheels. For locomotives having eight-coupled driving wheels and those having engine trucks or rear trailing wheels, the calculator must determine what pairs of wheels regulate the movement of the engine and take distance (c) accordingly.

COMPUTATION OF STRAIGHT LENGTH OF SAFETY CHAINS:

a. = Distance, in feet, from center of car to face of draw-bar when latter is pulled out to its extreme position;

b. = Distance, in feet, from center of car to inside bearing of first link in chain.

w. = Distance, in inches, from the center line of car to the center of the safety chain.

Use formula for computing distance (l) between the corner of the end sill and the line (h) on the outside of the curve, by substituting length, a, b and w, as given above. **The distance, l, obtained from the computation is the distance, in inches, from the safety-chain fixed bearing to the line h. Twice l is the straight length of both safety chains when hooked together.**

ELECTRICALLY OPERATED TURNTABLES.

The problem of operating turntables by power has recently received considerable attention in the columns of the railway engineering press. This subject is concisely stated in the following extract from a committee report of recent date to the Association of Railway Superintendents of Bridges and Buildings:

"The question of obtaining suitable power to facilitate the turning of locomotives by some motive power was brought to the front by the decided increase in the weight of locomotives during the last few years. The weight of locomotives used on some of the railroads to-day is such that they cannot be economically turned by hand, not only on account of requiring too many men to do the work, but the question of turning locomotives quickly at junctions and busy terminal points is a vital factor in considering the question as to what power to adopt to turn locomotives and other rolling stock, both promptly and economically. . . . On some of the eastern railroads locomotives weighing 175 tons, including the tender, are operated; such locomotives cannot, according to actual experience, be turned economically by hand, especially in the winter time." (The Atchison, Topeka & Santa Fe has an engine weighing 200 tons with the tender.)

A steam "donkey" or single-wheel locomotive is occasionally used for this purpose, attached to one end of the turntable and running on the same circular rail as the wheels of the turntable. The equipment usually consists of an upright boiler, a small steam engine and the inevitable coal bin. The entire arrangement is very inefficient, since economy is not an attribute of the type of boiler and engine which must be employed. It is necessary to continually supply coal and to remove ashes in small quantities and, in some communities, a licensed engineer is required by law. The suggestion has been made that steam might be conducted from a neighboring boiler plant, underground and up through the center of the turntable to a pivotal joint, thence to the "donkey" engine. Considerable difficulty would obviously be experienced due to condensation and this method cannot be recommended. Owing to the inherent disadvantaages of the steam "donkey," its use will never become general.

The electric motor possesses qualifications peculiarly valuable for work of this nature. A large number of turntables have been electrically equipped during the last few years and their successful operation leaves very little to be desired. A typical turntable equipment consists of a small railway motor with ordinary gearing, together with a rheostatic controller and a circuit breaker, usually mounted on a single-wheel truck.

The railway type of motor is especially adapted for this purpose, as it is completely enclosed and thoroughly water and dust-proof. The conditions of frequent starting and acceleration and large momentary overloads, correspond very closely to street railway work, where the series-wound direct-current motor is absolutely indispensable. In any case the motor must be designed and constructed to withstand rough usage, amounting often to positive abuse. The motor is usually provided with feet, as shown in Fig. 1, and in place of the car axle, an intermediate shaft is substituted, so that the armature of the motor drives the traction wheel through double reduction gearing. If there is sufficient space, it is well to follow street railway practice still further and enclose both gear reductions in gear cases, filled with oil. At this point it may be well to state that if the only available source of power is a multiphase alternator, an induction motor may be successfully employed. The motor should be designed for speed variation, with definite wound armature, collector rings and external resistances. A large turntable equipped with a three-phase variable speed induction motor has been in successful service for several months, readily handling the heaviest engines. Whichever type of motor is used, the armature shaft is usually extended at the end opposite the pinion, to accommodate a band brake. The brake should be normally applied by a weight or spring and released by a foot lever, or better still, by a shunt wound solenoid magnet (Fig. 1) connected so that the brake is automatically applied whenever the controller handle is in the "off" position. If this arrangement is used, a separate device for locking the turntable in position is unnecessary.

The controller is similar to the familiar street railway device, except that instead of using a separate reversing lever, the handle moves in either direction from a central "off" point. The few resistances required are also of the same form as used in street car equipments. The circuit breaker serves the double purpose of a switch and a protection for the motor, preventing any possibility of disastrous "short circuits" or injurious overloads. The electrical turntable possesses the following important advantages:

Simplicity of parts, low cost of maintenance and operation, can be operated by an unskilled attendant, rapid acceleration up to comparatively high speeds, large reserve capacity for momentary overloads, perfect speed control, consumption of power only when in actual service.

As intimated in the introductory paragraph, the time element is an extremely important consideration. With manual operation it is difficult to attain more than one-third of the speed of the electrical equipment. This is due to the rapid acceleration of the electric motor, the high turning speed and the ability to bring the turntable quickly to rest. At a certain busy terminal, the roundhouse was recently rebuilt with provision for twice the number of locomotives accommodated by the original structure. The superintendent stated emphatically that this very desirable concentration of locomotives was rendered possible only by operating the turntable electrically.

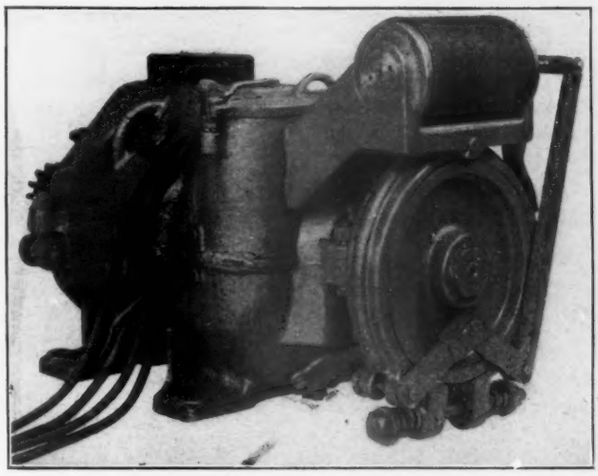


FIG. 1.

The power for operating the turntable may be obtained from the direct current power circuit (125, 250 or 500 volts) of the machine shop, or may be purchased at a nominal meter rate from a local illuminating or power company. The use of electric power has become so general that the conditions are very exceptional where a separate generator would be required for operating the turntable.

Where a large number of engines must be handled expeditiously, a regular turntable operator should be employed and a cab provided for his protection, as illustrated in Figs. 2 and 3. There are many cases, however, where it is feasible for the locomotive fireman to operate the turntable, in which event the controller may be located at the center of the table at one side, and a cab is not an absolute necessity. The details of the construction of the "donkey" with a cab are clearly shown in the illustrations. It will be noted that provision is made for sanding the rail in both directions. It is recommended that the mechanical features of the "donkey" be designed and constructed in the railroad shops wherever possible, the only

apparatus to be purchased outside being the electrical equipment.

The turntable illustrated in Fig 4 is an excellent design and embodies some novel features. The table proper is hung on a heavy cradle, which turns on a train of small wheels, following the usual draw-bridge practice. The cradle contains an electric motor with a vertical armature shaft, at the lower end of which a pinion engages with the teeth of a large stationary gear. The motor is an adaptation of the well-known GE-800 railway motor, and is located between the girders of the table.

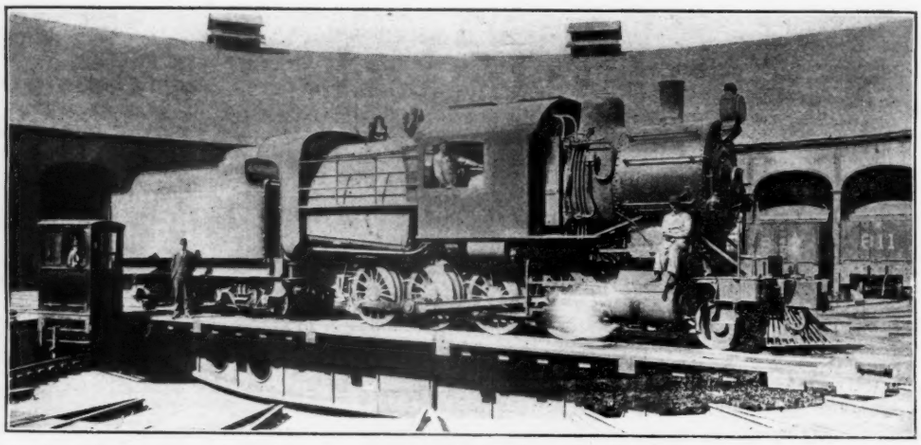


FIG. 2.

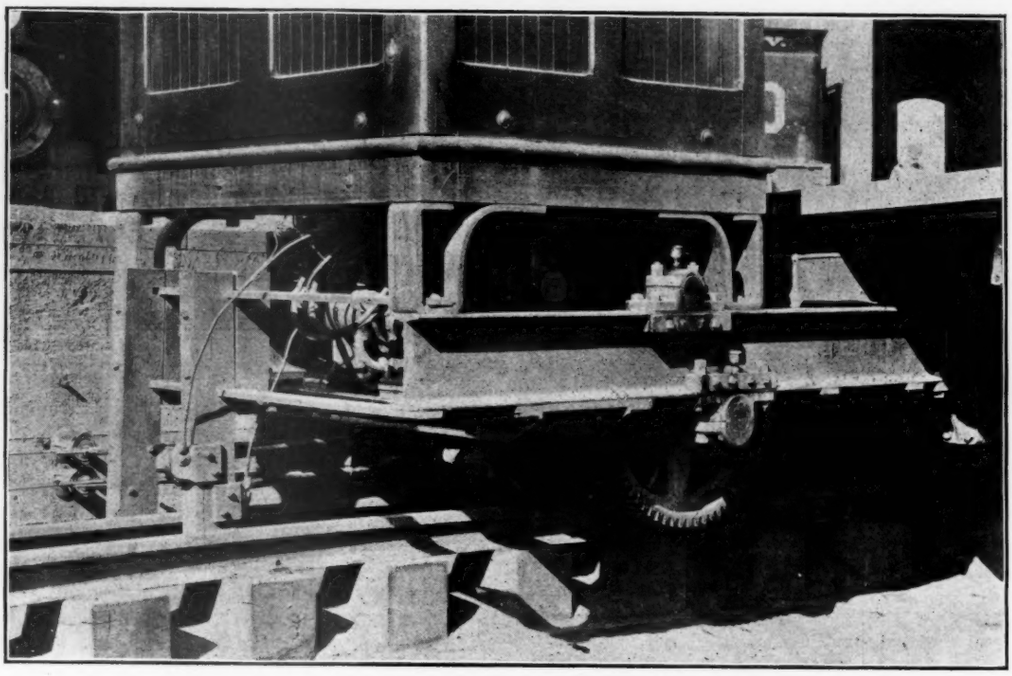


FIG. 3.

Electrically Operated Turntables.

There seems to be some misapprehension regarding the amount of power required to operate an ordinary turntable, due perhaps to the arbitrary basis on which motors of the railway type are rated. In lists of electrically operated turntables, the capacities of some of the motors are specified to be from 7 to 10 h.-p., while in the case of a turntable equipped with a railway motor, the capacity may be given at 20 h.-p. The difference lies, not in the capacity of the motors, but in the methods by which they are rated. The capacity of an electric motor is determined by the heating in the armature windings. On the ordinary basis a 10 h.-p. motor will operate at that load continuously, without a dangerous rise in the temperature of the windings. Street railway work, however, is so extremely intermittent that a continuous rating is irrelevant and an arbitrary basis of rating has been established. A 20 h.-p. motor, railway rating, will develop 20 h.-p. continuously for one hour, with a rise in temperature not exceeding 167 degrees F. If the load were continued steadily at that figure, the motor would burn in a few hours. A motor rated in accordance with this arbitrary method will operate intermittently at its full rating, and continuously at about one-third of its rating—i. e., a 20 h.-p. motor of the railway type will develop about 7 h.-p. continuously. It does not follow, however, that a 7 h.-p. motor, continuous rating, will develop 20 h.-p. intermittently, and it is therefore evident that a motor of the railway type is more suitable for turntable operation. The actual power required to turn a sixty-foot table, carrying an engine weighing 200,000 pounds, at the rate of one revolution in forty seconds varied, in one case from 8 to 12 h.-p., depending upon the position of the engine. At starting and during acceleration, however, the load on the motor was considerably greater. In this particular case the minimum power seemed to be required when the engine was slightly out of balance, the weight being divided between the center bearing and the wheels at one end of the turntable. In general, the statement may be made that, with electrically operated turntables, no time need be wasted in balancing the locomotives.

There are three practicable methods of conducting the current to the motor on the turntable, as follows:

1. By collector rings and brushes at the center of the turn-

table. 2. By trolley wires placed on the walls of the pit. 3. By an overhead device with collector rings and brushes.

The first method is by far the best, provided the design of the table permits its use. The wires from the power house are led underground and up through the center-casting to stationary collector rings. Attached to the turntable are brushes which collect the current from the stationary rings and maintain a perfect circuit, independent of the position of the turntable. This arrangement is the most simple and the least liable to give trouble. Many turntables, however, are built with center pivots cast solid, in which event the device described above cannot be employed. For a turntable of this description, the second method, illustrated in Fig. 3, is suggested. Two trolley wires, in chords of 6 or 8 ft., are

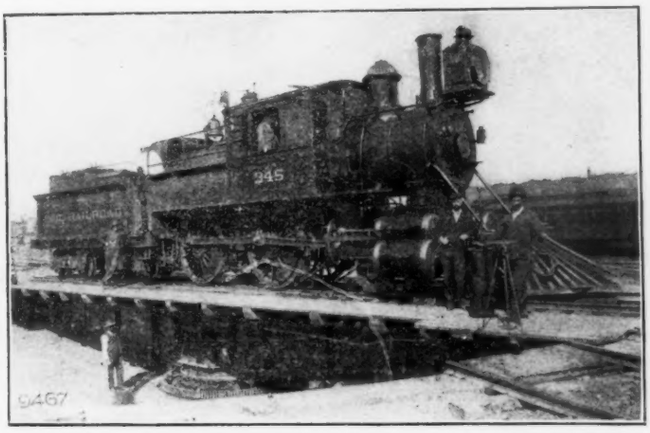


FIG. 4.

placed around the wall of the pit, supported by trolley hangers of the "toggle" type, ordinarily used in electric mine haulage. Short trolley poles are flexibly attached to the "donkey," so as to allow a horizontal movement on account of the variation in the trolley wires and a vertical movement to accommodate the tilting of the table. This scheme is simple and inexpensive and in practice has operated in a very satisfactory manner.

In some places, on account of the possibility of the pit being flooded, neither of the arrangements described above is practicable and it becomes necessary to collect the current from above the turntable. A very ingenious arrangement for this purpose has been used on a turntable at Long Island City, where the pit occasionally fills with sea water. A structure is erected at the center of the turntable and supports, directly above the pivotal point, a device embodying collector rings and brushes. Referring to Fig. 5, the case consists simply of a short piece of 8-in. steam pipe, with a regular steam cap, screwed on at each end. A bearing is provided at the top and a stuffing box at the bottom to accommodate a piece of 1-in. gas pipe, turned smooth on the outside. Attached to the gas pipe, which revolves with the table, is a hard wood insulating block with two copper rings, from which wires are led down through the pipe to the controller below. Two spring fingers, or brushes, are attached at diametrically opposite points to the inside of the iron case, which is held stationary by guy or feeder wires running to the roof of the roundhouse. The brushes are connected with the power circuit and maintain a constant connection with the collector rings. The case is filled with oil, which serves the double purpose of lubrication and insulation. The oil is an essential feature, as otherwise the insulation and contacts would be ruined by the gases and steam from the locomotives.

The cost of a turntable "donkey," similar to that shown in Fig. 2, amounts to approximately $1,000 as follows:

Single-wheel truck	$350
Electrical equipment	500
Installation, including contact arrangement	150
	$1,000

The cost of turning a locomotive by electric power depends upon the number of engines handled per day and upon the cost of the power. On one particular table, which handles 300 locomotives per day, the cost of the power is very much less than the cost of *hauling the coal* to the steam "donkey" previously employed. The following data, obtained from this installation may be of interest:

	Actual cost.	Cost at 4c. per kw. hr.	Cost at 6c. per kw. hr.
Cost of power per locomotive	$.0013	$.0034	$.0051
Cost of attendance	.0100	.0100	.0100
Total cost per locomotive	$.0113	$.0134	$.0151

The figures in the first column are an average covering six months and represent the actual cost, in this case, where the power was secured from the machine shop power plant and charged at the rate of 1.34 cents per kw. hour. The figures in the second and third columns are derived from the first column and represent the cost on the basis of rates at which power can ordinarily be purchased. From the figures above the extravagance of turning locomotives by hand is very apparent. It is by no means, however, entirely a question of expense. At an important junction or terminal, the expeditious handling of the locomotives is imperative and the advantages in this respect would usually outweigh the economy in dollars and cents.

From every standpoint turntables at busy terminals should be operated by power. The cost of power is less than that of

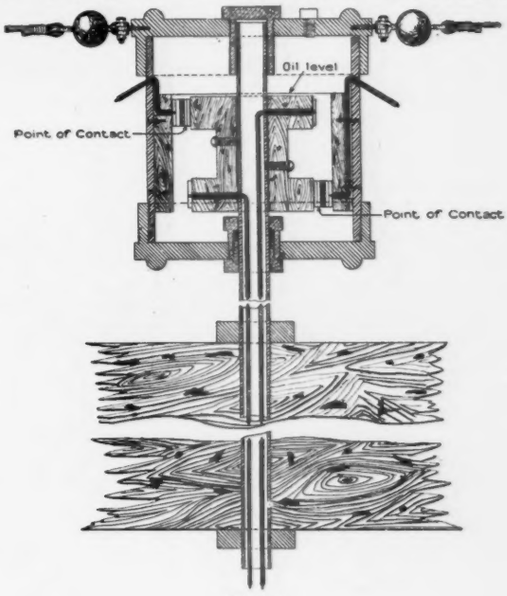


FIG. 5.

manual labor, and what is more important one man may always be depended upon to be on hand when a number of men cannot, and the saving of time is often far more important than the saving of cost of the work. Furthermore, in the winter a little snow may cause resistance to the turning of a table that is not to be overcome by even a large gang of men, whereas, a powerful motor will not be inconvenienced by it. With the present stress in locomotive service every minute counts and every important turntable should be driven by power. This principle is now accepted by progressive railroad officers.

The development of the alcohol industry in Germany is fostered by the government, because of the lack of petroleum deposits in that country. Denaturised alcohol, suitable for industrial purposes, is free from tax, whereas the alcohol for drinking is highly taxed. The result has been a great increase in the product from potatoes and other cheap sources. It has led to a development of the alcohol engine, which is important as well as interesting.

AUTOMATIC GREASE LUBRICATOR.

For Locomotive Driving and Truck Journals.

Delaware, Lackawanna & Western Railroad.

One of the most annoying and troublesome difficulties of railroad operation, and at the same time one of the most mysterious, is the occurrence of hot boxes. They are often produced by well known causes, and perhaps oftener by causes which are not known or understood. The latter are apparently not to be guarded against by usual methods. It is reasonable to suppose that a properly lubricated journal will not heat and that when one does heat it is because the surfaces for some reason become dry. Locomotive driving boxes present a difficult problem in this respect and in spite of all that has been done to avoid it they often give trouble and sometimes with serious results. Many devices have been tried for relief and yet hot journals continue. There seems to be no sure way of lubricating driving boxes with oil to insure freedom from heating.

If grease can be substituted for oil in this case, applied at the bottom of the journal, with no openings at the top of the bearing, there is reason to hope that relief may be found. Several months ago a trial of grease in this way was brought to our attention and it is, at least in the writer's experience, entirely new, although the lubrication of crank pins and other pins by grease is not at all unusual and is generally successful. We are permitted to place before our readers interesting facts concerning the development and operation of a new grease lubricator on the Delaware, Lackawanna & Western Railroad which is worthy of careful attention and investigation. The successful lubrication of the driving and truck journals of a passenger locomotive, promising 50,000 miles with one packing, at a cost of 4.3 cents per 1,000 miles, with an entire absence of hot journals, is an exceedingly important development, which has been brought about on this road under the direction of Mr. A. G. Elvin, Master Mechanic at Scranton.

Fourteen locomotives are now equipped with it, including some of the heaviest freight engines on the road, as well as passenger engines on the fastest and heaviest trains, making regularly 290 miles per day. Three of these passenger engines have been running with it since April last and in no case has there been the least trouble from hot boxes; furthermore, there has been no drop-pit work on any of these engines. Engine 977, in the accompanying record, has had an average of 9 lbs. 8 ozs. of grease applied to each box and, according to the consumption up to date, the packing should run 50,000 miles with enough left for a margin of 10,000 miles, which is the amount provided for safety to give the inspectors time to report for repacking.

The enginemen do not oil the boxes, except the shoes and wedges, and this means an important saving in time. It is the custom on many roads to pack the boxes daily and sometimes at each end of the run, in order to guard against the possibility of heating. This seems to be rendered entirely unnecessary by the plan described and the driving and truck boxes remain untouched.

Fig. 1 illustrates the lubricator applied to a driving box. Fig. 2 shows a block of grease with a follower plate under it ready to apply to an auxiliary cellar which is made of No. 16 steel with a perforated top formed to fit the journal. The follower plate is loose enough to slide easily in the auxiliary cellar and a spring urges it against the block of grease, toward the journal. The grease is fed through the perforations and comes into direct contact with the journal, maintaining at all times a generous film of grease between the perforated top and the journal. Fig. 3 is an end view of a cellar with the auxiliary cellar and grease in place. A small indicator wire protruding through the bottom of the cellar shows the position of the follower and the amount of grease in the box. When the indicator wire is flush with the bottom of the box there yet remains ¾ in. of grease at the shallowest part which, according to the records already made, should be sufficient for 10,000 miles for a passenger and 6,000 miles for a freight locomotive. In either case it is sufficient for at least a month's service after the indicator has passed out of sight. Fig. 4 shows the first experimental auxiliary cellar which was made of wood and lined with tin. It had a gauze netting on the top, next to the journal. The photograph was taken after 30,000 miles of service, in which 4 lbs. 11 ozs. of grease were consumed out of this box. Fig. 5 is the auxiliary cellar.

In using oil and waste, in the usual way, it is necessary to maintain a close fit between the cellar and the journal, in order to keep the packing in place and prevent the wasting of oil. After the engine makes considerable mileage and the brass is worn an opening occurs both in front and in the rear of the cellar, allowing waste to protrude. In many cases this catches fire from the ashpan sparks, especially on wide firebox engines, and a hot box is sure to result. With this grease device the

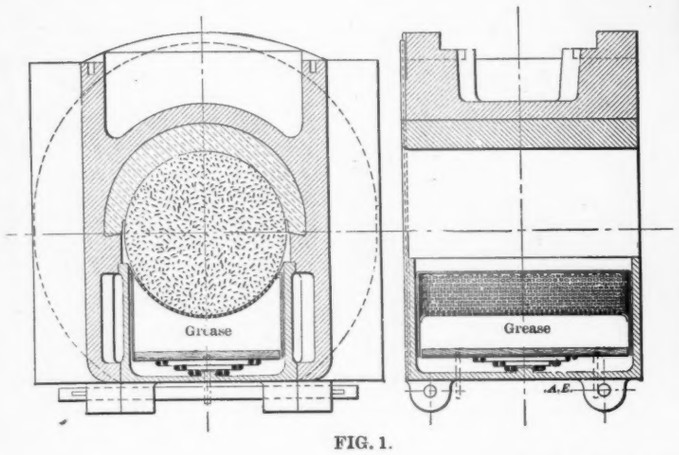


FIG. 1.

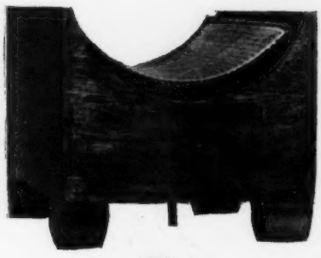


FIG. 3.

FIG. 4.

FIG. 2.

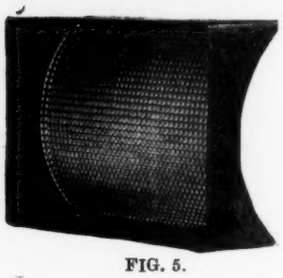


FIG. 5.

Automatic Grease Lubricator.

cellar need not fit the journal, as the auxiliary cellar is always kept against the journal by the spring. Mr. Elvin states that the engines mentioned have never given a moment of anxiety or a bit of trouble to the enginemen or roundhouse forces with reference to hot boxes since the beginning of the use of the grease. To determine the matter of wear the diameters of the journals were measured and the wear shown to be very slight considering the mileage made. This is indicated in the records below.

Statements of the records of mileage and the cost of the grease lubrication per 1,000 miles are appended. The comparison with oil is based upon the former allowance for these engines and does not take into account the oil which was ordinarily used in the roundhouse and often amounted to a relatively large item of cost. The records are as follows:

MILEAGE RECORD.

Engine. 991.	Date Applied.	Weight When Applied.		Am't Used Renew.	Weight, Sept. 7th.		Miles Made.	Amount Used.	Amount Used Per 1,000 Miles.
		lbs.	oz.	oz.	lbs.	oz.		oz.	oz.
Right rear	4-17-02	9	8	..	4	6	36421	82	2 1-3
Left rear	4-17-02	9	10	..	4	5	36421	85	2 1-3
Right main	4-21-02	10	..	6	4	8	35102	86	2 1-4
Left main	4-21-02	9	14	2	5	..	35102	80	2 1-3

COST RECORD.

Engine 991.	Cost of grease	$.04-3-10	per 1,000 miles.
Engine 991.	Cost of oil	.58	per 1,000 miles.
	Saved	.53-7-10	per 1,000 miles.
Engine 977.	Cost of grease	.04-8-10	per 1,000 miles.
Engine 977.	Cost of oil	.58	per 1,000 miles.
	Saved	.53-2-10	per 1,000 miles.
Engine 870.	Cost of grease	.10	per 1,000 miles.
Engine 870.	Cost of oil	.84	per 1,000 miles.
	Saved	.74	per 1,000 miles.

Passenger Engines.

Eight-wheel, 20 x 26-in cylinders, diameter of driving wheels 68 ins., 185 lbs. pressure, weight on drivers 93,000 lbs.

Engine 870.

Consolidation engine, 21 x 26-in. cylinders, diameter of driving wheel 56 ins., 200 lbs. pressure, weight on drivers 162,000 lbs.

RECORD OF ENGINE NO. 870.

Engine. 870.	Date Applied.	Weight, When Applied.		Am't Used Renew.	Weight, Sept. 7th.		Miles Made.	Amount Used.	Amount Used Per 1,000 Miles.
		lbs.	oz.	oz.	lbs.	oz.		oz.	oz.
Right 1	4-13-02	8	2	3	6	10	12305	24	2
Right 2	4-13-02	10	2	..	7	12	12305	38	3 1-6
Right 3	4-13-02	8	..	..	6	7	12305	25	2
Right 4	4-13-02	10	2	..	8	7	12305	29	2 1-2
Left 1	4-13-02	9	..	..	7	9	12305	23	2
Left 2	4-13-02	10	8	8	8	11	12305	29	2 1-2
Left 3	4-13-02	8	8	..	6	14	12305	26	2 1-6
Left 4	4-13-02	8	8	4	6	11	12305	29	2 1-2
Truck right	4-13-02	2	15	..	1	11	12305	20	1 2-3
Truck left	4-13-02	2	14	2	1	8	12305	22	1 5-6

Diameter of right second journal March 23d, 8 5-16-in.
Diameter of right second journal September 7th, 8 19-64-in.
Diameter of left second journal April 13th, 8 7-16-in.
Diameter of left second journal September 7th, 8 7-16-in. } No wear.
Diameter of engine truck journals April 13th, 6 in.
Wear up to September 7th, less than 1-64-in.

Note.—The amount of grease shown as used for renewal is due to changes in the gauze from the small mesh to the larger mesh.

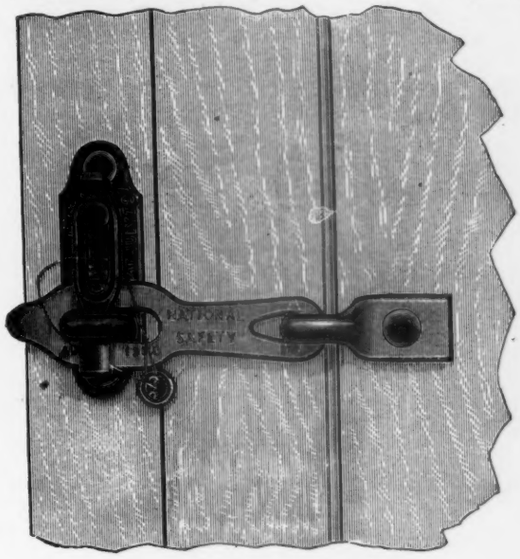
RECORD OF ENGINE NO. 977.

Engine 977.	Date Applied.	Weight When Applied.		Am't Used Renew.	Weight September 7th.		Miles Made.	Amount Used.		Amount Used per 1000 Miles.
		lbs.	oz.	oz.	lbs.	oz.		lbs.	oz.	oz.
Right rear	4-12 02	9	8	8	4	..	31326	5	8	2 3-5
Left rear	4-12-02	9	9	4	4	2	31326	5	6	2 2-3
Left main	4-21-02	9	8	..	4	13	31326	4	11	2 1-2
Right main	4-21-02	9	6	..	4	12	30376	4	10	2 1-2

Note.—Right back and left rear boxes changed from wood to steel box, necessitating adding eight ounces and four ounces of grease.

THE NATIONAL SAFETY CAR-DOOR FASTENER.

This door fastener, which is furnished complete in three pieces, has been improved and is believed to be proof against the well known practice of thieves who can pry the staple of the ordinary fastening, remove the lock and enter the car. With the ordinary hasp and staple the lock may be replaced



National Safety Car-Door Fastener.

and the door shows no indication of having been opened. With this new device, however, the door staple has a lip, as indicated in the engraving, and is secured by a bolt so that it cannot be removed. The hasp has been modined to adapt it to the new staple, out in other respects the fastening is identical with the well known National fastening and possesses all of the features of that device. The sealing pin is riveted to the staple plate and these parts go out as one piece. The riveting of the seal-

Sealing Pin and Door Staple of the National Fastener.

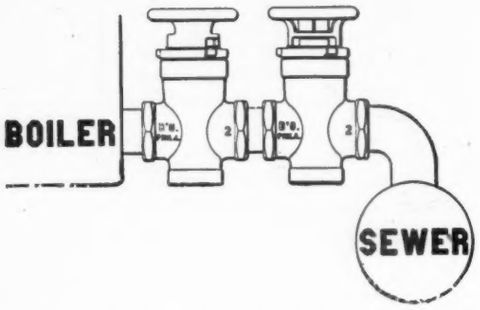
ing pin overcomes the difficulty of losing the pin and there are no chains or other loose parts to this fastener. Further information may be obtained from the National Malleable Castings Company, Cleveland, Ohio.

The Garvin Machine Company, New York, have recently issued subdivision catalogue No. 3, illustrating and describing their vertical milling machines, including their profiling machines and also their duplex milling machines. The Garvin company have adopted a very commendable practice in this respect, in that they are now informing their customers of their product by means of subdivided catalogues the various sections of which are brought up to date and issued at periodical intervals. In this way they are much better able to keep in touch with progress and give the trade prompt information regarding their improved, modernized machines. The machines described in this catalogue embrace the latest and most valuable improvements that are of advantage for those particular lines of work; yet greater improvements and further changes will be made upon them with the light of experience, and when made a new catalogue of that subdivision will be issued with respect to the latest improvements.

THE BORDO BLOW-OFF VALVE.

The Bordo valves are primarily intended to be used as blow-off valves for boilers. In this service they have proved very satisfactory and efficient. They have also given excellent service as blow-off valves on water columns and as stop valves between check valves and the boiler and between the water column and the boiler.

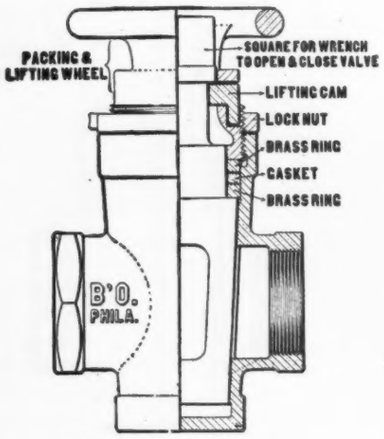
These valves are operated by means of a wrench on the square plug at the top in the hollow of the hand wheel. The hand wheel is fast to the packing gland, which when adjusted is permanently secured by a lock nut. Upon turning the hand wheel to the left the plug is lifted so that it may be easily



Duplicate Method of Connecting Bordo Blow-Off Valve to Stationary Boiler.

turned at any time. When the lock nut is turned up to the under face of the wheel a lifting cam, which couples the packing gland to the plug, may be pulled out and the gland is then free to be removed in order to repack the plug.

The accompanying part sectional engraving illustrates a straightway blow-off valve. This valve has a heavy shank, the outside diameter of which is the outside diameter of the next larger size pipe than that of the nominal dimension of the valve and discharge, thus insuring ample strength. When fitted to stationary boilers a desirable form of attachment is to



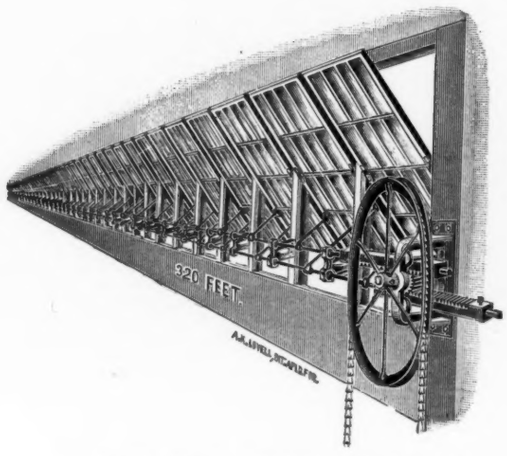
Bordo Blow-Off Valve.

place two of these valves in tandem in the blow-off pipe, as shown in the upper engraving. The valve next to the boiler is kept open except when the operating valve next to the sewer is to be packed. A special form of this blow-off valve, having a right-angle turn similar to that of an ordinary angle valve, is also made especially for locomotive use, the details of the gasket arrangement, lifting-cam, etc., remaining the same, however, as in the other form. Further information may be had from Mr. L. J. Bordo, 911 Filbert street, Philadelphia.

THE LOVELL WINDOW OPERATING DEVICE.

With the development of railroad shops into the large buildings of the present time mechanical devices for opening and closing windows are not only desirable from a labor saving standpoint but they are absolutely necessary in order to insure the prompt closing of the windows in case of storm. This becomes especially important in a building as large as 200 by 740 ft., a size which has been attained in railroad shop construction.

The devices illustrated were developed to meet this need, and one of the engravings shows a section of 320 ft. of sash operated

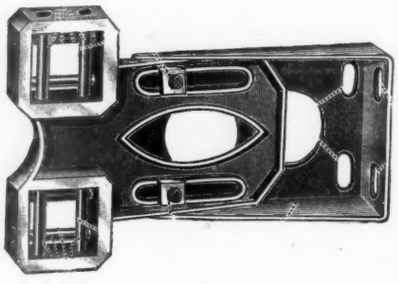


Lovell Window Operating Device.

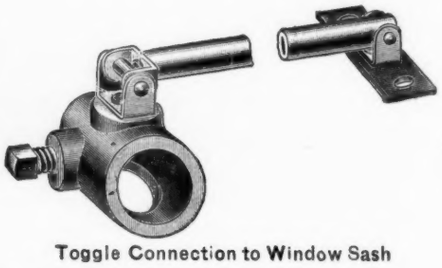
Showing 'nstallation Controlling 320 Feet of Window Sash.

from one station. This has recently been applied in a foundry in Bridgeport, Conn., and in other large buildings in the East and West. The apparatus is strong and durable and is made upon the Lovell patents by the G. Drouve Company, Bridgeport, Conn.

The engravings show the complete fixtures for operating a line of windows, with the sash partially open. A chain driving



Bracket Receiving Side Thrust of Rods.



Toggle Connection to Window Sash

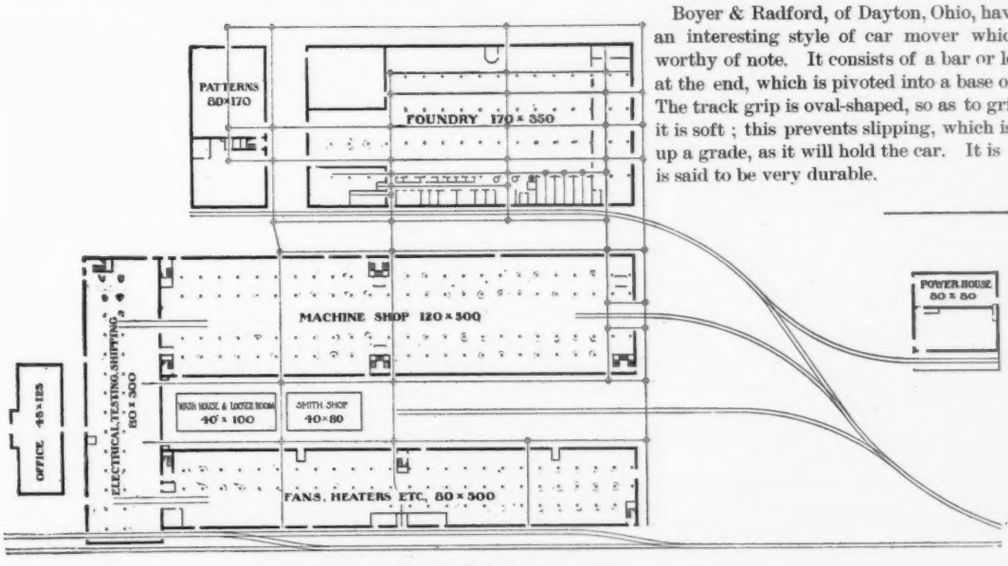
Lovell Window Operating Device.

the large wheel operates two racks, by means of a pinion between them. These racks are continued along the line of windows in the form of rods and open or shut the windows by means of toggle connections, one of which appears in the detail view. The rods move in opposite directions. The other detail illustrates one of the adjustable brackets with roller guides or bearings to carry the rods and take the thrust in opening and closing the windows. The manufacturers have brought to bear upon these devices their long experience as manufacturers and erectors of skylights and sheet metal work.

MANUFACTURING PLANT OF THE B. F. STURTEVANT COMPANY.

The new works of the B. F. Sturtevant Company, which are now nearing completion at Hyde Park, Mass., present an excellent example of carefully selected location and design for a modern manufacturing plant. The original plant at Jamaica Plain was limited in its opportunity for growth, and its capacity has long been strained to the utmost; the fire which occurred last year forced an immediate change, and the new site was selected after careful consideration of all the factors of supply of raw materials and skilled labor, and also as to shipping facilities. The new site at Hyde Park, which is only six miles from the old plant, contains 20 acres of land and has a frontage of 1,300 ft. on the freight yard of the New York, New Haven & Hartford Railroad. One side of the lot is bounded by a stream furnishing a plentiful water supply, and the adjacent shore is at a level 10 ft. below that of the yard and buildings, thus providing sufficient space for dumping waste material for years to come.

Careful consideration was given to the size and character of the buildings as to the requirements of the individual departments. Plans were made with the idea of providing a total floor space slightly more than double that of the old plant, and as conditions did not favor a group of one-story buildings, and also as simple calculations showed the actual cost of power expended in a single year for lifting the entire product of the works through a distance of 20 ft. figured only a little over a dollar, the company determined upon the building of multi-storied buildings. The arrangement of the buildings was determined by considerations of the provision for future growth.


PATTERNS 80×170
FOUNDRY 170 × 350
MACHINE SHOP 120×300
POWER HOUSE 80 × 80
WASH HOUSE & LOCKER ROOM 40 × 100
SMITH SHOP 40×80
ELECTRICAL TESTING SHIPPING 80 × 300
OFFICE 45×125
FANS, HEATERS ETC. 80 × 500

New Plant of the B. F. Sturtevant Co.

This arrangement, illustrated in the accompanying plan, provides for a group of buildings parallel to the railroad tracks, with accommodation for switch tracks between buildings and their entrance at the ends of the building, and an abundant opportunity for growth by extensions in length.

The latest development of all-steel and concrete construction with large window areas did not appear to meet the requirements of comfort to workmen, convenience in attaching machines on hangers, etc., so that the type of building selected is composite in its character, consisting of steel interior columns and main steel girders, with heavy brick walls, wood timbered floor and plank roofs. In the case of the one-story foundry, the roof is supported by steel trusses; in the other buildings open timbering with wooden columns in the upper floor is employed. The main floor in the machine shop is of tar concrete, with spruce and maple flooring. The upper floors are carried upon wooden beams spanning the spaces between the steel girders, which follow a unit system of 20 ft. on centers through the building. All roofs are of 3-in. plank, with tar and gravel top.

For power it was decided that the entire plant shall be electrically driven from a central power house, the engines to run condensing, and the exhaust steam from the engines to be utilized for heating, with supplementary supply of live steam admitted at reduced pressure as required.

The equipment of this plant will involve many interesting features as to the product of the Sturtevant Co. Beginning with the power plant, Sturtevant mechanical draft apparatus, instead of natural draft, will be used. The buildings will be heated by a Sturtevant hot-air system, the shafting and individual machines driven by motors of the same make, the refuse from the wood-working machinery, the dust from the cleaning room of the foundry, and the removal of smoke from the smith shop will be accomplished by Sturtevant exhaust fans, while Sturtevant blowers will be used for brass and iron foundry, forge-shop blast and the like, and Sturtevant steam traps will be employed upon the steam driers. The engines and generators in the power plant will also be of Sturtevant make.

EQUIPMENT AND MANUFACTURING NOTES.

The Russell Car and Snow-Plow Company are building new shops at Ridgway, Pa., where they will in the future manufacture the well-known Russell snow plows and flanges, and special freight and miscellaneous cars, instead of at Boston as formerly.

Boyer & Radford, of Dayton, Ohio, have recently placed on the market an interesting style of car mover which involves several advantages worthy of note. It consists of a bar or lever of solid tool steel, hardened at the end, which is pivoted into a base or track grip of malleable iron. The track grip is oval-shaped, so as to grip the rail on the corners, where it is soft; this prevents slipping, which is of advantage in moving cars up a grade, as it will hold the car. It is well-built and is powerful, and is said to be very durable.

The Chicago Pneumatic Tool Company report that on account of the large amount of business they are receiving from the Southwest they have been obliged to again place a representative in that district, having located their Mr. W. C. Walker in St. Louis, with headquarters at 325 Lincoln Trust Building, which arrangement will facilitate handling the volume of business received from that territory.

The Barber truck, sold by the Standard Car Truck Company, Chicago, is to be used under the following new equipment: Seven hundred and fifty 50-ton hopper cars for the Norfolk & Western Railway, now building at their plant at Roanoke, Va.; 1,000 gondola cars for the Erie Railway, to be built by the Standard Steel Car Company, of Pittsburgh, for January 1, 1903, delivery; 1,300 cars for the Chicago, Milwaukee & St. Paul Railway, now being built by them at their West Milwaukee car works; 75 30-ton box and flat cars for the Duluth & Iron Range Railway, to be built by the Western Steel Car and Foundry Company for November delivery; 1,000 30-ton flats and 500 30-ton box cars for the Canadian Pacific Railway, to be built by car plants in Canada; and 2,500 cars for the Central Railroad Company of New Jersey.

Mr. B. F. Pilson, general contracting agent of the Ajax Metal Company, has removed from Richmond, Va., to Washington, D. C., where his headquarters will be in the Sun Building.

BOOKS AND PAMPHLETS.

Proceedings of the Western Railway Club. For the club year 1901-1902.

This volume comes as an annual reminder of the sensible and dignified policy of this organization in placing in the hands of every member a bound volume of the proceedings of the year. This seems preferable to the use of the funds for less permanent and profitable purposes. This plan, furthermore, influences the character of the work of the club, because its papers and discussions are known to be part of a permanent record. It should be adopted by the other clubs. These volumes are uniform with the Master Mechanics' and Master Car Builders' proceedings as to form and size, and are close to them in value and importance.

Materials of Machines. By Albert W. Smith, Professor of Mechanical Engineering, Leland Stanford University; 142 pages; illustrated. John Wiley & Sons, 43 East Nineteenth street, New York. Price $1.00.

As stated in the preface, "This book is the result of an effort to bring together concisely the information necessary to him who has to select materials for machine parts." It has five chapters and an index, the subjects being as follows: Outline of the metallurgy of iron and steel, testing, stress-strain diagrams, wrought-iron and steel and alloys. Too much can hardly be said in praise of this little book. It gives the information needed in using materials in designing machines, and is compact and concise. The engineer will read it with advantage and it is an excellent text book for the student.

American Railway Master Mechanics' Association. Proceedings of the Thirty-fifth Annual Convention, 1902. Published by the association. Edited by the secretary, J. W. Taylor, Rookery Building, Chicago.

This volume is the best issued by this association in a number of years. The subjects of the papers are important and interesting, and the engravings throughout the book are the best to be found in all of the volumes issued. In addition to the rules, records of resolutions and standards, the book contains a number of valuable papers and reports. Among these the following are specially worthy of mention: A paper on "Electric Driving for Shops," by C. A. Seley; a report upon "Up-to-Date Roundhouses," a report upon "Present Improvements in Boiler Design and Best Proportions of Heating and Grate Surfaces for Different Kinds of Coal"; a paper on "A Typical Shop to Serve a Road Having 300 Locomotives," by L. R. Pomeroy, and a paper on "Modern Water-Supply Stations for Locomotives," by F. M. Whyte. The volume has 453 pages and an index. The activity of the secretary in getting out these annual volumes is noteworthy. To produce such a satisfactory work of such a character in nine weeks after the close of the convention is a task worthy of praise and appreciation.

The Lunkenheimer Company, Cincinnati, Ohio, have issued a revised edition of their 1898 catalogue involving several changes of list prices. This catalogue illustrates and describes, as is probably well known, brass and iron valves of all types, injectors, whistles, lubricators, oil and grease cups and steam specialties. The Lunkenheimer Company report that great interest is being taken in their "Duro" boiler blow-off valve which was recently placed upon the market; this valve is so built that no scale or sediment can lodge on its seat, and will prove very durable.

"Twenty-fifth Anniversary of the Compound Locomotive." An interesting pamphlet bearing this title has been received from the author, Mr. A. Mallett, of Paris, commemorating the twenty-fifth birthday of the compound locomotive. Mr. Mallett was the first to place the compound in practical form, his first engine having been put into service on the Bayonne & Biarritz Railway, June 2, 1877. This engine was of the two-cylinder type. In twenty-five years the number in use has become nearly 15,000, of which about two-thirds are of the two-cylinder type. Of this number, more than 500 of the author's articulated, four-cylinder type have been successfully placed in service. The address of Mr. A. Mallett is 30 Avenue Trudaine, Paris, France.

Mr. W. F. DeGarmo, Eastern representative of the Falls Hollow Staybolt Company, has changed his headquarters from 3116 Clifford street, Philadelphia, to 60 West Ninety-third street, New York.

The Robert Aitchison Perforated Metal Company, Chicago, Ill., have issued a pamphlet on perforated metals, showing the various general types of perforations made by them in all kinds of sheet metal and for all purposes Over 600 varieties are standard with this company, while any special size or shape of perforation may be had from them.

A catalogue of "Metropolitan" Injectors has recently been received from the Hayden & Derby Mfg. Company, 85-89 Liberty street, New York. The Metropolitan, Automatic, "1898" and double tube types of injectors, as well as ejectors and jet apparatus, are illustrated and described. Also considerable information is given regarding their operation.

"Packing Sense" is the title of a pamphlet that has been gotten out by the United States Metallic Packing Company, Philadelphia, Pa., intended for those who are now using United States metallic packing. It is a very well-written, concise statement of the principle and details of this packing and sets forth many points to be looked after for the best results with it. The company desires that all persons interested in the care and maintenance of their packing shall have a copy, and will send same on request.

"Three Electric Cars of the Most Advanced Type" is the title of a beautifully designed and illustrated circular recently issued by the J. G. Brill Company, Philadelphia, Pa. The three patented cars made by this company, covering practically the whole field of electric passenger service, are very fully illustrated and described—first, their "semi-convertible" car; second, their "convertible" car, and then their "Narragansett" style open summer car. The "convertible" car made by this company should be received very favorably by the street-railway companies, as it combines in a most convenient manner the advantages of both the open and the closed cars, and thus, if used exclusively, would reduce the rolling equipment of a road by nearly one-half.

An illustrated descriptive pamphlet of great interest has recently been issued by the Rand Drill Company, New York, entitled: "New York Rapid Transit Tunnel." It is a large 55-page, 9x11 inch book, beautifully illustrated with views of all sections of the tunnel showing the various processes of construction, together with the progress up to date. In the construction of this important tunnel a great deal of rock was met and had to be cut through, and for this purpose numerous large air compressor plants were installed and are still in operation furnishing compressed air for the thousands of rock drills used—all the compressor plants, as well as the rock drills, being furnished by the Rand Drill Company. The enormity of this wonderful undertaking is comprehensively set forth by the beautiful half and full page half-tones with which the pamphlet is profusely illustrated; this tunnel easily distances any undertaking of its kind ever made, and the work done by the Rand Drill Company's apparatus is certainly a credit to them.

Destruction of property by fire is universally dreaded, and yet it constitutes one of those ever-present dangers which often lead to neglect of the most ordinary precautions. Attention should be given to the fire-protection equipment of shops so that it will be known to be always in first-class condition; but one must be impressed with the neglect of this important precaution in visiting railroad shops. It is not so among the mills and factories of New England and elsewhere under the jurisdiction of the Associated Factory Mutual Insurance Companies and the National Fire Protection Association. Such plants are obliged to equip with fire hose which fully meets the requirements of these organizations. A circular has just been received from the Boston Belting Company which directs attention to this important subject and illustrates the American Underwriters' cotton and linen fire hose. The cotton hose is for outside use on portable reels and on yard hydrants. It is made in 50-ft. lengths, of woven material, lined with rubber. The linen hose is for inside use in cases requiring the hose to be hung up in warm rooms or corridors. It is light, compact and convenient, and is made in any desired length. Both of these brands are made to conform with the requirements of the two companies referred to, and both are accepted and recommended by them. The address of the Boston Belting Company is 256 Devonshire street, Boston, Mass.